

AD-A066 564

TIPPETTS-ABBETT-MCCARTHY-STRATTON NEW YORK

F/G 13/2

NATIONAL DAM SAFETY PROGRAM. SODOM DAM (EAST BRANCH RESERVOIR) --ETC(U)

JUN 78 E O'BRIEN

DACW51-78-C-0024

NL

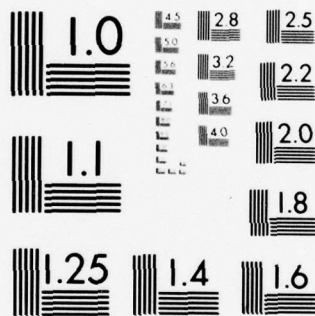
UNCLASSIFIED

1 OF 1

AD
A066564



END
DATE
FILMED
5-79
DDC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

DDC FILE COPY

AD A0 66564

70 03 20 1966

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Croton River Basin Sodom Dam (East Branch Reservoir) Putnam County, New York Inventory No. N.Y. 31		5. TYPE OF REPORT & PERIOD COVERED Phase I Inspection Report National Dam Safety Program
7. AUTHOR(s) 10 Eugene O'Brien		6. PERFORMING ORG. REPORT NUMBER
9. PERFORMING ORGANIZATION NAME AND ADDRESS Tippetts-Abbett-McCarthy-Stratton 345 Park Avenue New York, New York 10021		8. CONTRACT OR GRANT NUMBER(s) 15 DACW-51-78-C-8024
11. CONTROLLING OFFICE NAME AND ADDRESS Department of the Army 26 Federal Plaza / New York District, CofE New York, New York 10007		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)		12. REPORT DATE 11 30 June 1978
		13. NUMBER OF PAGES
		15. SECURITY CLASS. (of this report) UNCLASSIFIED
16. DISTRIBUTION STATEMENT (of this Report) Approved for public release; Distribution unlimited.		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE
17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report) Inventory no. 31		
18. SUPPLEMENTARY NOTES National Dam Safety Program, Sodom Dam (East Branch Reservoir) Croton River Basin, Putnam County, New York (31). Phase I Inspection Report, N		
19. KEY WORDS (Continue on reverse side if necessary and identify by block number) Dam Safety National Dam Safety Program Visual Inspection Hydrology, Structural Stability Putnam County Croton River Basin Sodom Dam NYC Water Supply System		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report provides information and analysis on the physical condition of the dam as of the report date. Information and analysis are based on visual inspection of the dam by the performing organization. Sodom Dam was judged to be safe, no remedial action was required.		

411040

2

CROTON RIVER BASIN

**SODOM DAM
(EAST BRANCH RESERVOIR)
PUTNAM COUNTY, NEW YORK
INVENTORY NO. 31**

**PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM**



Prepared by: TIPPETTS-ABBETT-McCARTHY-STRATTON

This document has been approved
for public sale; its
distribution is unlimited.

NEW YORK DISTRICT CORPS OF ENGINEERS

MAY 24, 1978

79 03 26 106

CROTON RIVER BASIN
SODOM DAM
INVENTORY NO. 31
PHASE I INSPECTION REPORT

TABLE OF CONTENTS

	<u>Page No.</u>
- ASSESSMENT	-
- OVERVIEW PHOTOGRAPH	-
1 PROJECT INFORMATION	1
1.1 GENERAL	
a. Authority	1
b. Purpose of Inspection	1
1.2 DESCRIPTION OF PROJECT	1
a. Description of the Dam	1
b. Location	2
c. Size Classification	2
d. Hazard Classification	2
e. Ownership	2
f. Use of Dam	2
g. Design and Construction History	3
h. Normal Operating Procedures	3
1.3 PERTINENT DATA	4
a. Drainage Area	4
b. Discharge at Dam Site	4
c. Elevation	4
d. Reservoir	4
e. Storage	4
f. Dam	4
g. Spillway	5
h. Regulating Outlets	5
2 ENGINEERING DATA	
2.1 DESIGN	6
2.2 CONSTRUCTION RECORDS	6
2.3 OPERATION RECORDS	6
2.4 EVALUATION OF DATA	7

ACCESSION for	
NTIS	State Section <input checked="" type="checkbox"/>
DDC	Bull Section <input type="checkbox"/>
UNANNOUNCED	<input type="checkbox"/>
JUSTIFICATION	
BY	
DISTRICT	OTHER AGENCIES
Date	
A	

		<u>Page No.</u>
3	VISUAL INSPECTION	8
3.1	FINDINGS	8
a.	General	8
b.	Embankment Dam	8
c.	Masonry Dam	8
d.	Spillway	8
e.	Appurtenant Structures	8
f.	Regulating Gates	8
g.	Abutments	9
h.	Downstream Channel	9
i.	Reservoir Area	9
3.2	EVALUATION OF OBSERVATIONS	9
4	OPERATIONAL AND MAINTENANCE PROCEDURES	10
4.1	PROCEDURES	10
4.2	MAINTENANCE OF THE DAM	10
4.3	MAINTENANCE OF OPERATING FACILITIES	10
4.4	WARNING SYSTEMS IN EFFECT	10
4.5	EVALUATION	10
5	HYDRAULIC/HYDROLOGIC	11
5.1	DRAINAGE AREA CHARACTERISTICS	11
5.2	SPILLWAY CAPACITY	11
5.3	RESERVOIR CAPACITY	11
5.4	FLOODS OF RECORD	11
5.5	OVERTOPPING POTENTIAL	12
5.6	EVALUATION	12
6	STRUCTURAL STABILITY	13
6.1	EVALUATION OF STRUCTURAL STABILITY	13

		<u>Page No.</u>
a.	Visual Observations	13
b.	Design and Construction Data	13
c.	Operating Records	13
d.	Post Construction Changes	13
e.	Seismic Stability	13
7	ASSESSMENT/REMEDIAL MEASURES	14
7.1	DAM ASSESSMENT	14
a.	Safety	14
b.	Adequacy of Information	14
c.	Necessity for Additional Investigations	14
7.2	REMEDIAL MEASURES	

DRAWINGS

VICINITY MAP
 TOPOGRAPHIC MAP (USGS)
 GENERAL PLAN, MASONRY DAM
 CONTOUR MAP, MASONRY DAM
 PRINCIPAL SECTION, MASONRY DAM
 PLAN, SECTION AND ELEVATION OF DAM AND GATE HOUSE
 TYPICAL SECTION OF DAM
 MISCELLANEOUS DETAILS, DAM

APPENDIX

- A. Photographs
- B. Engineering Data Checklist
- C. Visual Inspection Checklist
- D. Hydrologic Data and Computations

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam: SODOM DAM (I.D. NO. 31)
EAST BRANCH RESERVOIR

County Located: PUTNAM COUNTY

Stream: EAST BRANCH, CROTON RIVER

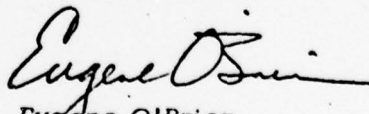
Date of Inspection: 27 APRIL 1978

ASSESSMENT

Examination of the available documents and visual inspection of the Sodom Dam and appurtenant structures did not reveal any conditions which are unsafe. Maintenance of the project features is adequate.

The total discharge capacity of the spillway and regulating gates without overtopping the dam is approximately 37,700 cfs. This is less than the estimated probable maximum flood of 87,000 cfs, but greater than the standard project flood of 34,100 cfs., both as determined using Corps of Engineers' screening criteria. This is therefore adequate in accordance with the Corps of Engineers adopted general principle that structures be designed for the maximum flood reasonably characteristic of the region which is, in practice, the Standard Project Flood.

Additional investigations to assess the safety of the dam and appurtenant structures do not appear to be warranted. It is recommended that an operation and maintenance manual be prepared for the project and that a program of periodic inspections be established.

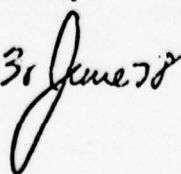

Eugene O'Brien

New York No. 29823



Col. Clark H. Benn
New York District Engineer

Approved By:

Date: 30 June 78




OVERVIEW OF MASONRY DAM

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
SODOM DAM, INVENTORY NO. 31
CROTON RIVER BASIN
PUTNAM, NEW YORK

SECTION I PROJECT INFORMATION

1.1 GENERAL

a. Authority

The Phase I inspection reported herein was authorized by the DEPARTMENT OF THE ARMY, NEW YORK DISTRICT, CORPS OF ENGINEERS by letter dated 31 March 1978, in fulfillment of the requirements of the National Dam Inspection Act, Public Law 92-367, 8 August 1972.

b. Purpose of Inspection

The purpose of this inspection and report is to investigate and evaluate the existing conditions of subject dam in order to: identify deficiencies and hazardous conditions; determine if they constitute hazards to human life or property; and notify the State of New York of these results along with recommendations for remedial measures where necessary.

1.2 DESCRIPTION OF PROJECT

a. Description of the Dam

The Sodom Reservoir is formed by a cyclopean masonry gravity section, built across the East Branch of the Croton River, and by an embankment dam approximately 600 ft long and 9 ft high, constructed nearly at right angles to the masonry structure on a ridge to the east of it. A 500 ft long masonry overflow wall, approximately 10 ft high with a sill at El 417 above mean tide, Hudson River at Sing Sing (El 416.55 above M.S.L. at Sandy Hook) is located north of the embankment dam.

The principal dimensions of the masonry dam are as follows:

Length at coping	500 ft
Maximum height above foundation	98 ft
Maximum height above ground surface	78 ft
Top width	12 ft
Width at foundation	53 ft

The embankment section has a crest width of 20 ft and upstream and downstream slopes of 1 (V): 2 (H). The upstream face below El 421+ is covered by riprap paving stones. The embankment has a rubble masonry core wall which is approximately 3.0 ft wide at the top (El 420)

and 8 ft wide at the base.

Flow from the reservoir is regulated at a gate house built on the upstream face near the center of the masonry dam. Two parallel channels are provided in the intake tower, each with an overflow weir (El 410) which can be raised by stop planks set in grooves, and 2 ft x 5 ft sluice gates at mid-level (sill El 382) and bottom level (sill El 352). A downstream valve vault contains two 48-inch valves for the main 48-inch outlet lines which discharge via a fountain into the East Branch of the Croton River. In addition, there is a 36-inch branch valve from each of the main lines which control flow to a common header with 12-inch branch valves for 12-inch pipes to the 80-ft diameter fountain. Water exits the fountain over a weir and flows into the East Branch Channel which is lined with hand placed riprap.

The Sodom Reservoir is connected to the Bog Brook Reservoir by a 10-ft diameter tunnel, and both are often called the "Double Reservoir I". While both reservoirs have about the same capacity, the watershed area of the former is nearly 20 times greater than the latter. The Bog Brook Reservoir is not furnished with a spillway.

b. Location

The dam is located on the East Branch of the Croton River approximately 0.3 miles south of Sodom and 1.5 miles upstream of Brewster, in Putnam County.

c. Size Classification

The dam is just less than 100 ft high and impounds less than 50,000 acre-feet; therefore, it is considered to be an "intermediate" size dam.

d. Hazard Classification

The dam is in the "high" hazard potential category.

e. Ownership

The Sodom Dam is owned and operated by the New York City Bureau of Water Supply (BOWS); day-to-day operation and maintenance are managed from the Carmel Section of the East-of-Hudson Division of the BOWS.

f. Use of Dam

The impoundment provided by the dam is a water storage reservoir for the City of New York.

g. Design and Construction History

The dam and appurtenances were designed by the Aqueduct Commission of New York. The contract for construction of the dam was awarded to Sullivan, Rider and Dougherty on December 30, 1887; work was completed by October 31, 1892.

h. Normal Operating Procedures

Water releases from the Sodom Reservoir, either from the regulating gates or over the service spillway, flow into the East Branch of the Croton River and to the Croton Reservoir. There is little operation of the regulating gates which usually are set to release 5.0 mgd into the East Branch.

1.3

PERTINENT DATA

- a. Drainage Area, sq. miles 76.92⁽¹⁾
(1) includes Bog Brook
- b. Discharge at Dam Site, cfs
Maximum known flood at site (Oct. 16, 1955) 6,600
Maximum regulating gate outlet 300
Ungated Spillway, El 321 13,300
Ungated Spillway, El 325 37,700
Total discharge capacity at maximum pool 38,000
- c. Elevation (feet above meantide, Hudson River at Sing Sing)
Top of dam 425
Maximum design pool (Top of riprap) 421
Spillway crest 417
Stream bed at centerline of dam 347
- d. Reservoir
Length of Maximum design pool, miles 1.8
Length of shoreline at El 417, miles 10.5
Surface area at El 417, acres 536.8
- e. Storage acre-feet
Top of spillway crest (El 417) 16,100
Maximum design pool (El 421) 19,000
Top of dam (El 425) 21,000
- f. Dam
Masonry Section
Type: Cyclopean masonry with stone facing
Length: 500 ft
Height: 98 ft above foundation
Top width: 12 ft
- Embankment Section
Type: Earth Embankment with rubble masonry central core wall
Length: 600 ft
Crest Width: 20 ft
Side Slopes: 2.0 (H) on 1.0 (V)
- Impervious core: Rubble masonry, 3 ft± wide at top and 8 ft± wide at base
- Grout Curtain: None

g. Spillway

Type: Masonry wall
Length: 500 ft
Crest Elevation: 417 ft above Mean tide, Hudson River
at Sing Sing
416.55 ft above M.S.L. Sandy Hook
Gates: Ungated
Approach Channel: None
Downstream Channel: 400 ft long tailrace channel narrowing
to 100 ft width to East Branch
of Croton River.

h. Regulating Outlets

Weirs and multi-level sluice gates at gate house to two 48-inch discharge pipes, with flow regulated by 48-inch gate valves and 12-inch fountain valves. Gate house weir at El 411; 2 ft x 5 ft gate inverts at El 382.0 and El 352.0.

SECTION 2: ENGINEERING DATA

2.1 DESIGN

The design of the dam was made by the Aqueduct Commission of New York prior to 1887. There are no design computations or specific design memoranda available for the project features.

The available information on the dam consists of:

a. Drawing entitled "The Aqueduct Commission Plan of Masonry Dam, etc., East Branch Reservoir, Sodom, Putnam County, October 14, 1887. (BOWS Reference No. 4265-X)

b. Drawing of Masonry Dam Cross Section, undated (circa 1887) showing some design parameters. (BOWS Reference No. 3918-X)

c. The Aqueduct Commission Reports on the New Croton Aqueduct Dams and Reservoirs,

1887-1895	(Drawings)
1895-1907	(Description)

d. Edward Wegmann, The Design and Construction of Dams, Sixth Edition, 1918 (John Wiley & Sons, Inc.)

e. Schematic of Gate house for "Double Reservoir 'I', East Branch Reservoir, Sodom Dam, undated (BOWS Reference No. 17817-Z)

Drawings found in (c) are considered to be most representative of the project as built. Early drawings indicate steps in spillway tailrace channel. The steps do not exist. Notes in (c) and on (e) indicate that spillway crest level was permanently raised from El 415 to El 417 in 1905. Drawing (a) notes location of "soundings" and depths to rock and "hardpan".

2.2 CONSTRUCTION RECORDS

No detailed construction records are available; however, there are brief narratives pertaining to the construction of the dam in Wegmann's text and also in the Aqueduct Commission's Reports.

2.3 OPERATION RECORDS

There is a written record of gate operation, maintenance and repair work orders. There is no operation and maintenance manual for the project.

There is a record of pool elevation and rainfall on a daily basis.

2.4 EVALUATION OF DATA

Existing data were made readily available at either BOWS' New York City Offices and at the Carmel Section Office.

The available data reviewed are considered adequate for this Phase I inspection and evaluation of safety.

SECTION 3: VISUAL INSPECTION

3.1 FINDINGS

a. General

A visual inspection of Sodom Dam was made on Thursday, April 27, 1978. At that time the reservoir level was at approximate El 417.16.

b. Embankment Dam

There were no visible signs of sloughing, erosion, cracking or other distress on either the crest or upstream and downstream slopes of the dam. No seepage was visible. There were some minor ruts on the downstream slope; these were apparently caused by the tractor mower used to maintain the grass slope protection. The grass slope protection appeared to be generally well maintained.

The riprap was hand placed, tight and in good condition.

c. Masonry Dam

The visible surfaces of the masonry dam were in good condition; there were no signs of seepage, movement or other distress.

d. Spillway

At the time of the inspection water was flowing over the spillway. However, the condition of sill and visible portions of the masonry spillway wall were in good condition. The spillway tailrace channel did not contain steps as shown on the early drawings.

e. Appurtenant Structures

There were no signs of distress, movement or seepage at any of the appurtenant structures, except for a small amount of seepage emerging from a weep hole at the base of the south spillway masonry training wall, at a location approximately midway between the spillway sill and the East Branch. Near the same location are some apparent erosion channels in the exposed rock above the spillway floor.

f. Regulating Gates

Stems at all four sluice gate operating stands were in the raised (gate open) position about 60 inches. Wooden stop logs were in both downstream weir slots and extended approximately 22 inches above the water surface. Thirty nearly new metal stop logs (55 in. x 80 in.) were stored in the gate house.

The visible portions of the gate stems were pitted from rust in the vicinity of the guides near water level. The guide support for the upstream (bottom sluice gate) was scaled due to corrosion.

In the downstream valve vault, the left 48-inch valve was closed and the right 48-inch valve was "cracked" open. Both of these valves appeared to be of the butterfly type, well lubricated and in relatively new condition. It was said that these valves replaced the original valves sometime prior to 1960.

The 36" branch gate valves were well lubricated and easily operated. Packing at left valve was dry; the packing at the right valve was damp.

The 12-inch fountain valves, from right to left were:

1. Closed (no stem packing leakage)
2. Part Open (some leakage at packing)
3. Closed (no stem packing leakage)
4. Closed (slight stem packing leakage)
5. Closed (slight stem leakage)

g. Abutments

There were no signs of seepage downstream of the dam on either the west abutment of the masonry dam or the ridge below the embankment which also forms the east abutment of the masonry dam.

h. Downstream Channel

The downstream channel, which is the East Branch of the Croton River, is riprap lined for some distance north of the confluence of the fountain channel and the spillway tailrace channel.

i. Reservoir Area

In the vicinity of the dams, there was no evidence of sloughing, potentially unstable slopes or other unusual conditions which would adversely affect the dam.

3.2 EVALUATION OF OBSERVATIONS

Visual observations made during the course of the inspection did not indicate conditions which would adversely affect the dam.

SECTION 4: OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 PROCEDURES

The minimum required water release at Sodom Dam is 5 mgd. The release is made through the gate house and regulated using the sluice gates, the 48-inch gate valves and the 12-inch fountain valves. There is generally little or no regulation other than maintaining the 5 mgd releases.

4.2 MAINTENANCE OF THE DAM

There is no operation and maintenance manual for the project. The project is visited daily by the watershed inspector who does not necessarily examine the dam or other project features. There is no formally established program of inspection visits by other BOWS personnel.

Maintenance of the embankment dam, which involves only periodic mowing of the grass slope protection, appears to be adequate, except for the growth of some small brush near the top of the riprap.

No regular maintenance procedures are established for the masonry structure or spillway, both of which are in good condition.

4.3 MAINTENANCE OF OPERATING FACILITIES

In the gate house and intake tower, and valve vault, visible equipment appeared well maintained. The gate hoist stands were well lubricated and operated easily, as did the 36" branch valve for the fountain. Records showed that gates and valves were "exercised" at intervals in the order of 6 to 20 months.

4.4 WARNING SYSTEMS IN EFFECT

There is no warning system in effect or in preparation.

4.5 EVALUATION

There appears to be nothing in the present operational or maintenance procedures which would adversely affect the safety of the project. Maintenance of the Sodom Dam and appurtenant features is considered to be adequate.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 DRAINAGE AREA CHARACTERISTICS

The Sodom Dam and Reservoir is located on the East Branch, Croton River at the East-Central boundary of the Croton River Basin. The total Drainage Area at the Sodom Dam is 80.3 square miles. The topography, typical of a glaciated region, is characterized by steep hills and ridges interspersed with flat valleys, in a general north-south direction, containing lakes and swamps. The lakes and swamps are believed to provide substantial natural storage, which in turn would modify the peak flood runoff.

5.2 SPILLWAY CAPACITY

The spillway is uncontrolled, and 500 ft in length. In shape, it consists of a flat crest followed by a stepped downstream face. The maximum head possible between the crest and the top of the dam is 8.0 feet. A spillway discharge rating table, up to a depth of 2.50 feet was supplied by the Department of Water Supply, but it was necessary to estimate the discharges between 2.50 feet and 8.0 feet. A weir coefficient of 3.33 was assumed and the computed capacity at maximum head is 37,700 cfs. The spillway rating curve is shown on Figure 1 of the Appendix.

5.3 RESERVOIR CAPACITY

The total reservoir capacity at the spillway crest is 5,243 million gallons (16,100 acre-feet). The storage capacity curve, based on a table furnished by the Department of Water Supply is shown on Figure 2. The capacity curve has been extrapolated to an elevation corresponding to the top of the dam, and indicates a surcharge storage above the spillway crest of 4,780 acre-feet.

5.4 FLOODS OF RECORD

The greatest floods in the Croton River since the completion of the Croton River Dam in 1905 and probably since the completion of the Sodom Dam in 1891 were in August and October of 1955. The records of these floods at the Sodom Dam are as follows:

Date	Elevation	Head	Discharge	
	Feet	Feet	cfs.	cfs/sq.mi.
Aug. 20, 1955	419.48	2.48	6555	80
Oct. 16, 1955	419.50	2.50	6576	82

The flood in August was caused by 8.84 inches of precipitation August 11-13, followed by 6.13 inches on August 17 and 18. The eight-day total was 15 inches. The October storm was more concentrated with a total of 12.05 inches in three days from October 14-16 inclusive, of which 8.15 inches fell on October 15. The discharge per square mile resulting from these extraordinary storms appear to be relatively low and may reflect the retarding effects of the natural storage in the basin.

5.5 OVERTOPPING POTENTIAL

The maximum spillway discharge capacity of 37,700 cfs has been compared with generalized design flood criteria as explained below. The Probable Maximum Flood (PMF) for the 80.3 square miles drainage area has been extrapolated from maps of Probable Maximum Flood potential for selected sizes of drainage area.(1) The smallest drainage area for which floods have been plotted was 100 square miles. The extrapolation to 80.3 square miles must be considered approximate, but indicates a PMF peak inflow of about 87,000 cfs. or about 2.3 times the spillway discharge capacity.

A second criteria for evaluating a design flood is the Standard Project Flood (SPF), which is usually about one half the PMF. Derivations of the SPF in the Lower Hudson Basin are available in a report made for the Corps of Engineers.(2) Data in this report permitted the interpolation of the SPF for an area of 80.3 square miles, and indicated a flood potential of 425 cfs per square mile - a total discharge of 34,100 cfs or 90.5% of the spillway capacity.

5.6 EVALUATION

The estimated Probable Maximum Flood inflow of 87,000 cfs and the Standard Project Flood inflow of 34,100 cfs must be considered as representing potential inflow to a reservoir from a drainage area that has little natural and/or artificial storage. To properly evaluate the relation between the Sodom Dam spillway capacity and the probable outflow from these design floods, it would be necessary to develop and route these floods through the surcharge storage. A greater refinement would require development of sub-area hydrographs which would be routed through the natural storage in each sub-area. Without detailed analysis it is not possible to say whether or not the spillway capacity is adequate relative to the runoff from the Probable Maximum Flood, but the capacity is obviously adequate to pass the Standard Project Flood.

(1) Design Basis Floods for Nuclear Power Plants, Regulatory Guide 1.59, U.S. Nuclear Regulatory Commission, Revision 2, August 1977.

(2) Lower Hudson River Basin Hydrologic Flood Routing Model, Water Resources Engineers, Inc. January 1977.

SECTION 6: STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Visual observations did not indicate either existing or potential conditions which would adversely affect the structural stability of the embankment dam, masonry dam or spillway.

b. Design and Construction Data

There exists no design computations or other data regarding the structural stability of the dam.

On the basis of the performance experience of the embankment dam, as well as engineering judgment, the embankment section of the dam is considered to be stable.

Although there are no design computations available, it is likely that the masonry gravity sections were designed in accordance with the appropriate sections of E. Wegmann's text, DESIGN AND CONSTRUCTION OF DAMS, 6th Edition dated 1918, in which a cross section of Sodom Dam appears. If the gravity sections were designed accordingly, the stability of the gravity section would be considered to be adequate. Performance experience with the maximum water level 2.5 ft above the spillway crest level is good.

c. Operating Records

Records of gate operation and repairs are available at the Carmel Section Office of the BOWS. No major operational problems which would affect the stability of the dam were reported.

d. Post Construction Changes

There are no recorded post construction changes other than raising of the spillway crest from El 415 to El 417.

e. Seismic Stability

The dam is located in Seismic Zone No. 1; therefore, no seismic analyses are warranted.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 DAM ASSESSMENT

a. Safety

Examination of the available documents and visual inspection of the Sodom Dam and appurtenant structures did not reveal any conditions which are unsafe. Maintenance of the project features is adequate.

The total discharge capacity of the spillway and regulating gates without overtopping the dam is approximately 37,700 cfs. This is less than the estimated probable maximum flood of 87,000 cfs, but greater than the standard project flood of 34,100 cfs., both as determined using Corps of Engineers' screening criteria. This is therefore adequate in accordance with the Corps of Engineers adopted general principle that structures be designed for the maximum flood reasonably characteristic of the region which is, in practice, the Standard Project Flood.

b. Adequacy of Information

The information and data available were adequate for performance of this investigation. However, there are some inadequacies in information with regard to operation and maintenance of the project, as follows:

1. Record drawings of the project
2. Operation and maintenance manuals
3. Records of inspections

c. Additional Investigations

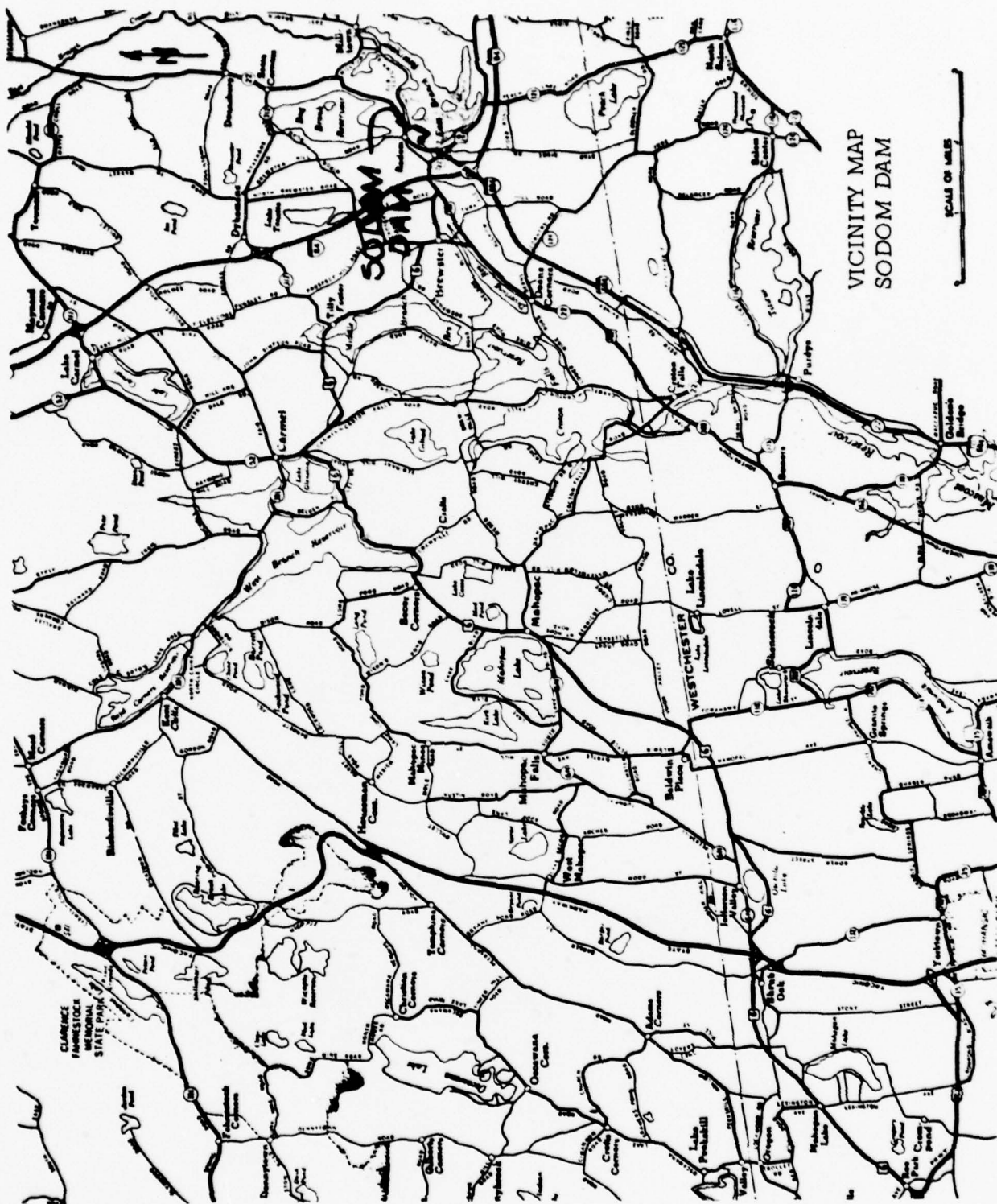
Additional investigations to assess the safety of the dam and appurtenant structures do not appear to be warranted.

7.2 REMEDIAL MEASURES

No remedial measures are required at the present time.

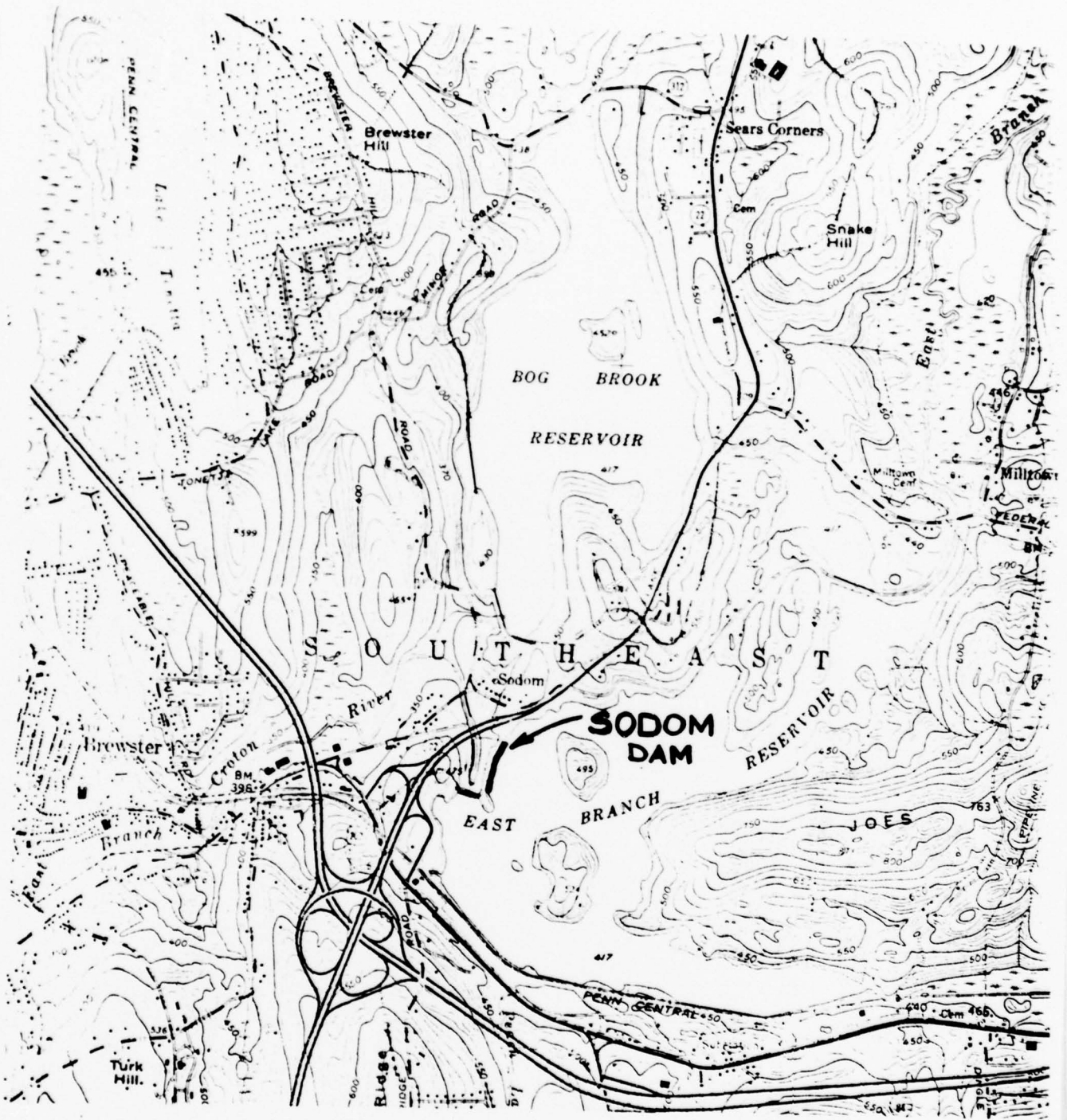
Certain measures, however, are recommended as follows:

- a. Prepare an Operation and Maintenance Manual
- b. Establish a program of periodic inspections of the project features

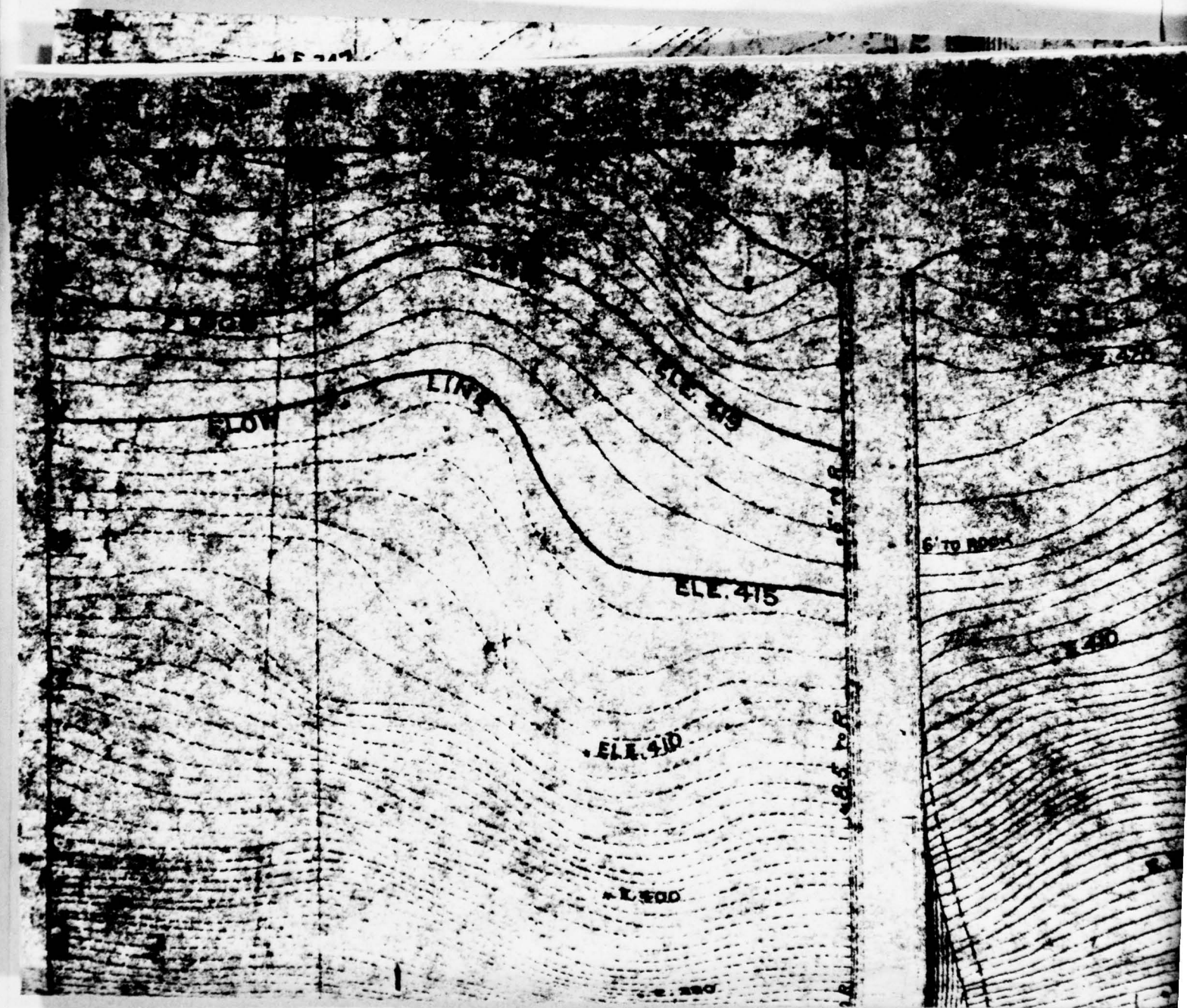


VICINITY MAP
SODOM DAM

SCALE OF MILES



TOPOGRAPHIC MAP
SODOM DAM & RESERVOIR

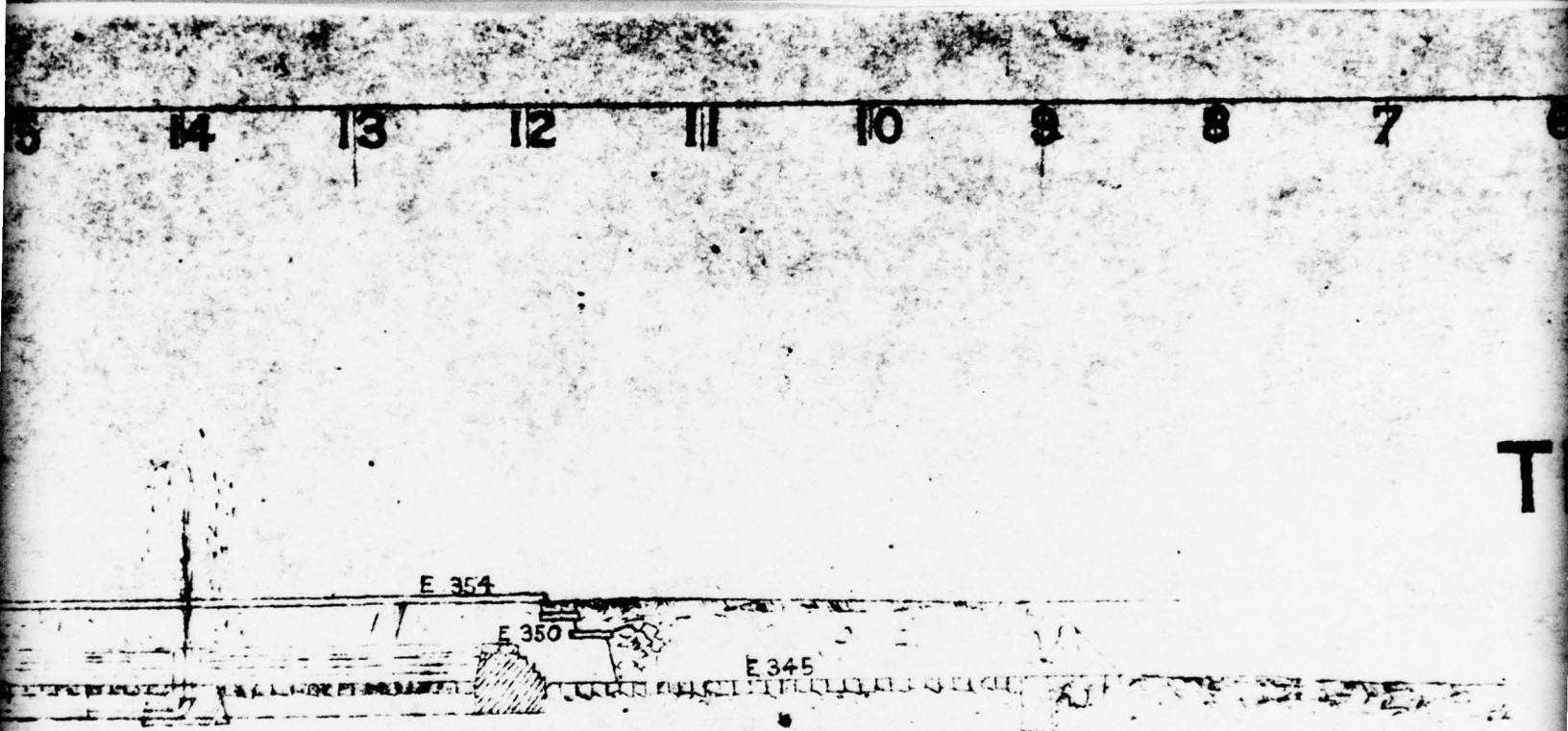


19 18 17 16 15



THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDQ

2



SECTION OF FOUNTAIN

(SEE SHEETS N^o 7 & 8)

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

*This drawing is reproduced
from the Bureau of Water
Supply Reference No. 4265-X*

THIS PAGE IS BEST QUALITY
FROM COPY FURNISHED TO

7 6 5 4 3 2 1 0

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

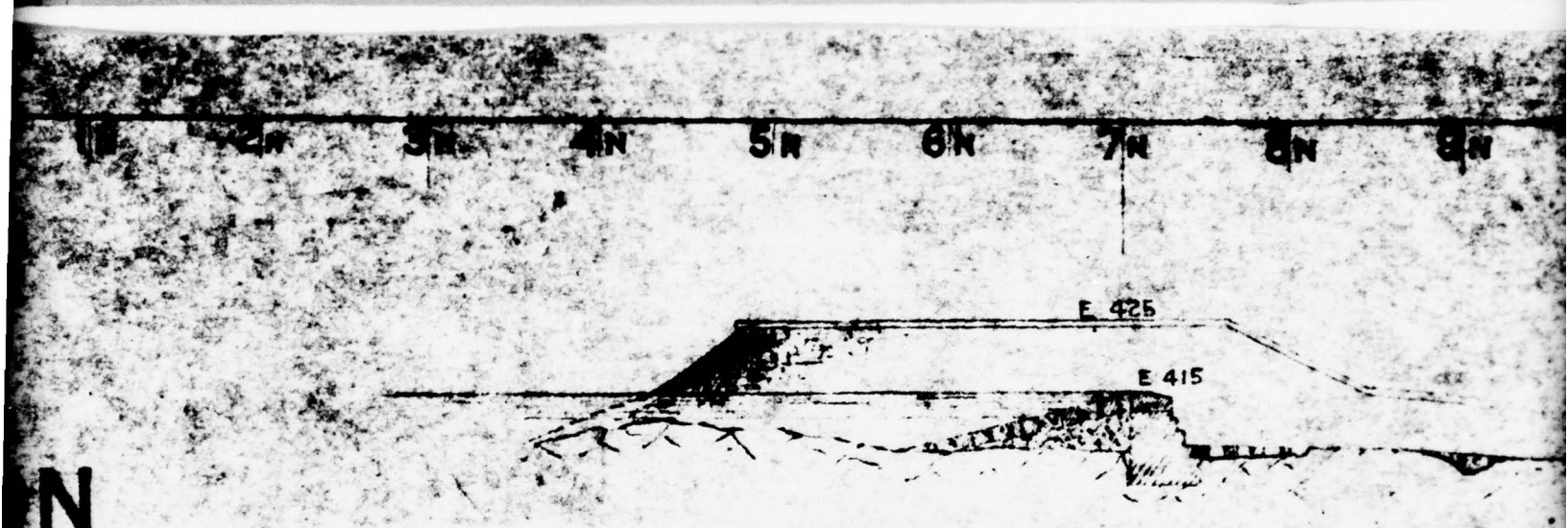
THE AQUEDUCT COMMISSION
PLAN OF
MASONRY DAM, ETC.
AT
EAST BRANCH RESERVOIR
SODOM
PUTNAM COUNTY
N. Y.
SCALE.

ed
5-X

PAGE IS BEST QUALITY PRACTICABLE
COPY FURNISHED TO DDG

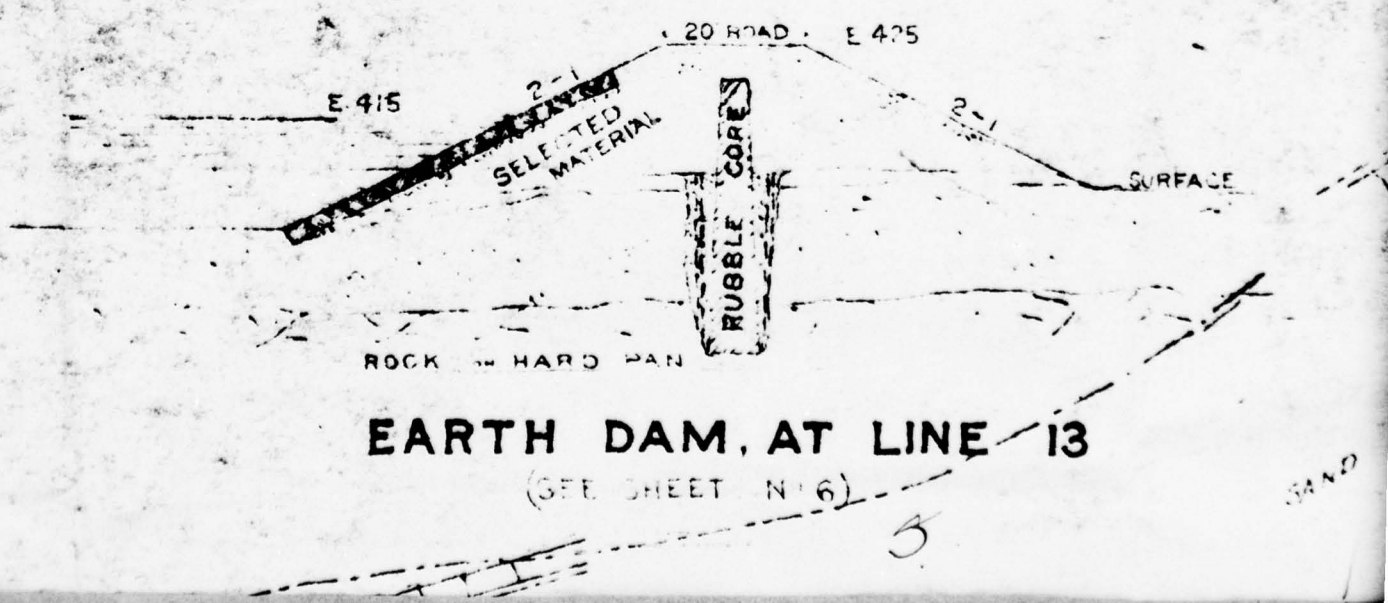
0 25 75 100

4



**SECTION OF OVERFALL DAM,
ON LINE 11N.**

(SEE SHEET N° 6 & 10)



EARTH DAM, AT LINE 13

(SEE SHEET N° 6)

8N

9N

10N

11N

12N

13N

14N

15N

16N

THIS PAGE IS BEST QUALITY
FROM COPY FURNISHED TO

DAM,

SURFACE

THIS PAGE IS BEST QUALITY PRACTICALLY
FROM COPY FURNISHED TO DDG

SAND

BOULDERS

350

139 to R 30FT

17N 18N 19N 20N 21N 22N

SHEET NO 2

BEST QUALITY PRACTICABLE
FURNISHED TO DDO

SEE SHEET NO 10

E 351

E 355

E 360

E 365

E 370

E 375

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDO

7

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

E. 380

E. 370

E. 360

(SEE SHEET NO 3)
(N° 485)

4' TO ROCK

BED ROCK

DAM 500' LONG

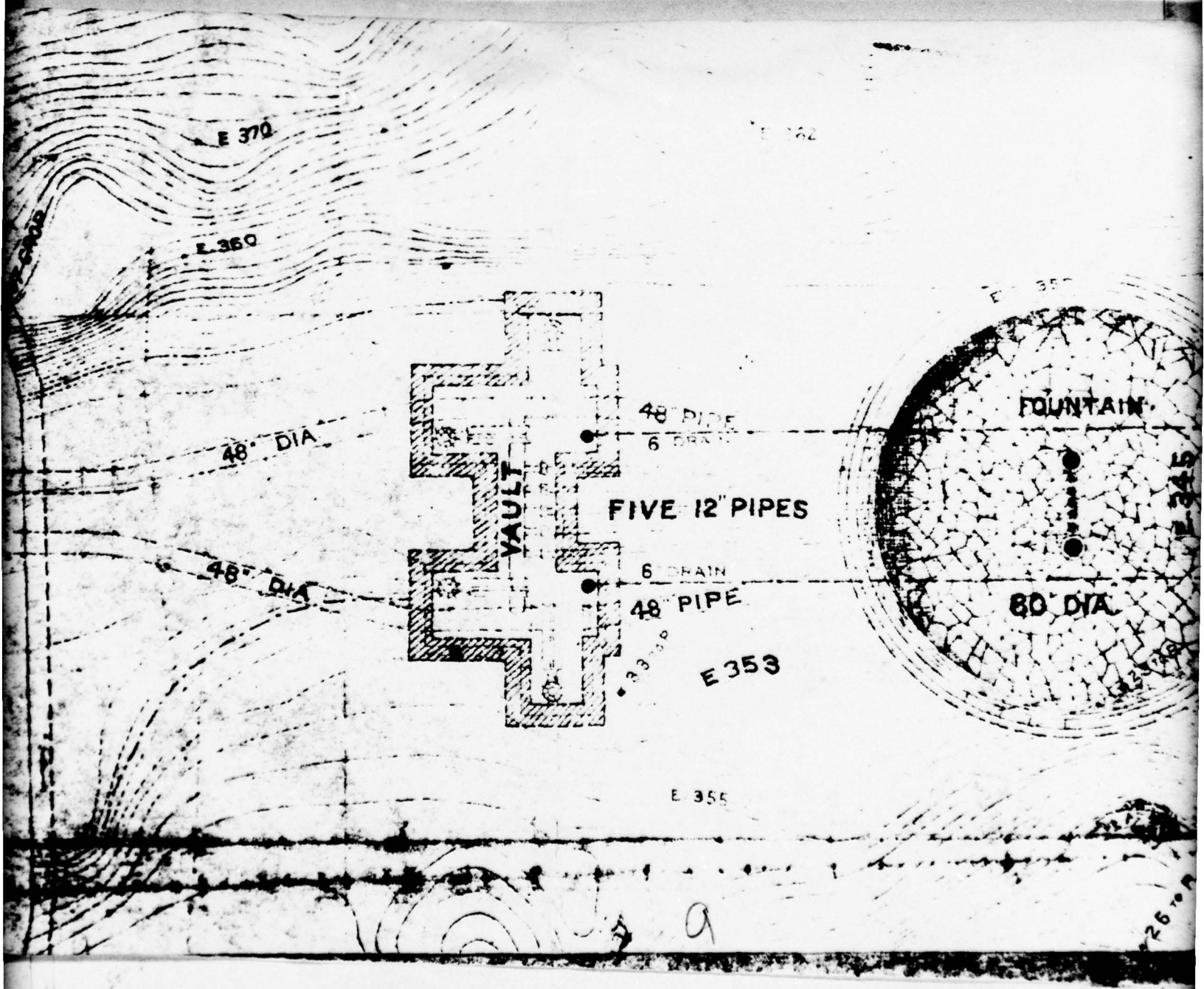
ELE 425

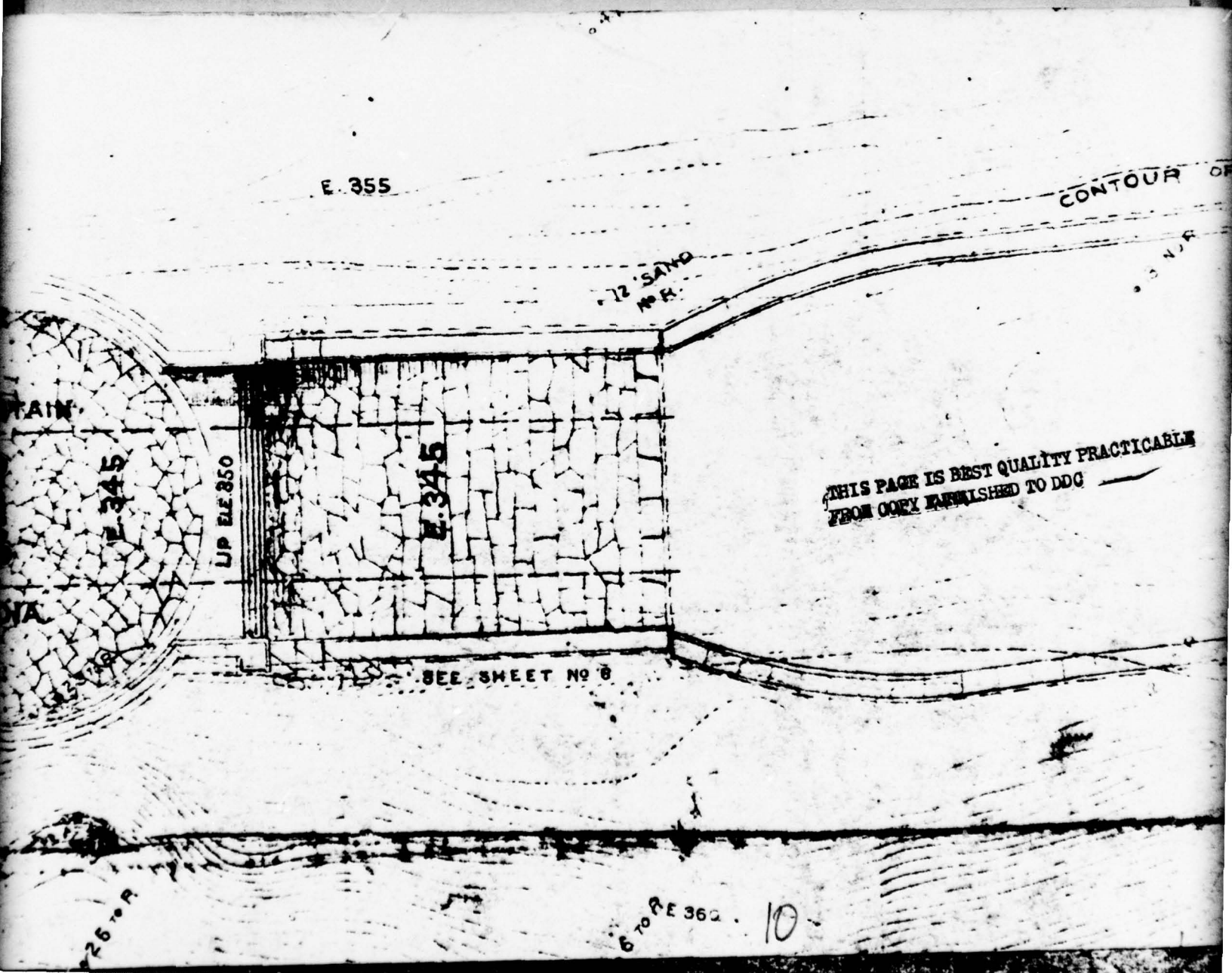
ROADWAY

3.75

OUT CROP

BED





THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

0 5 10 15 20 25

N.B. DEPTH OF SOUNDINGS TAKEN
FROM ORIGINAL SURFACE

CONTOUR OF PRESENT MILL POND

SEE SHEET NO 10

CHIEF

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

ITY PRACTICABLE
DDC

CC FOUR

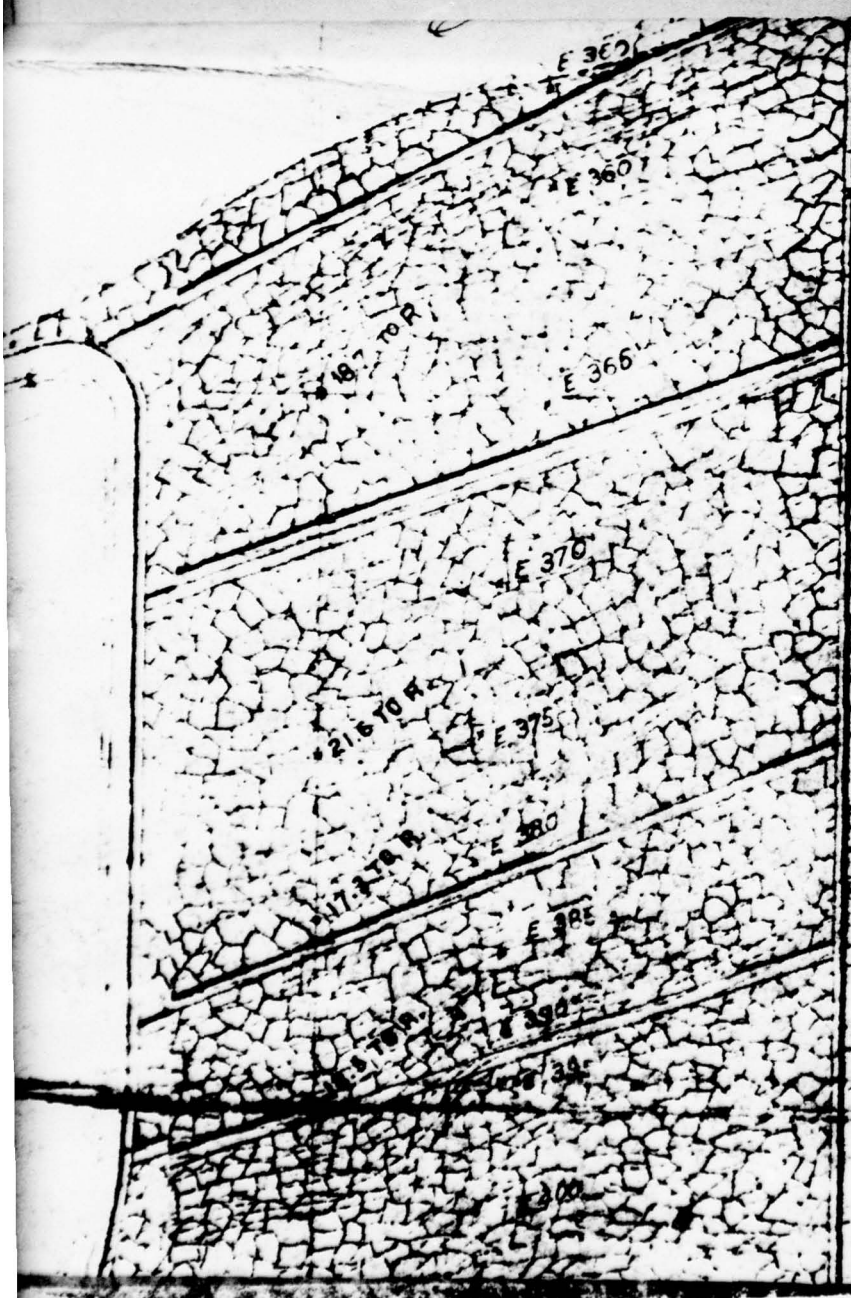
ENGINEER
OCT 14 1887

RIVER BED

OF PRESENT

MILL POND

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG



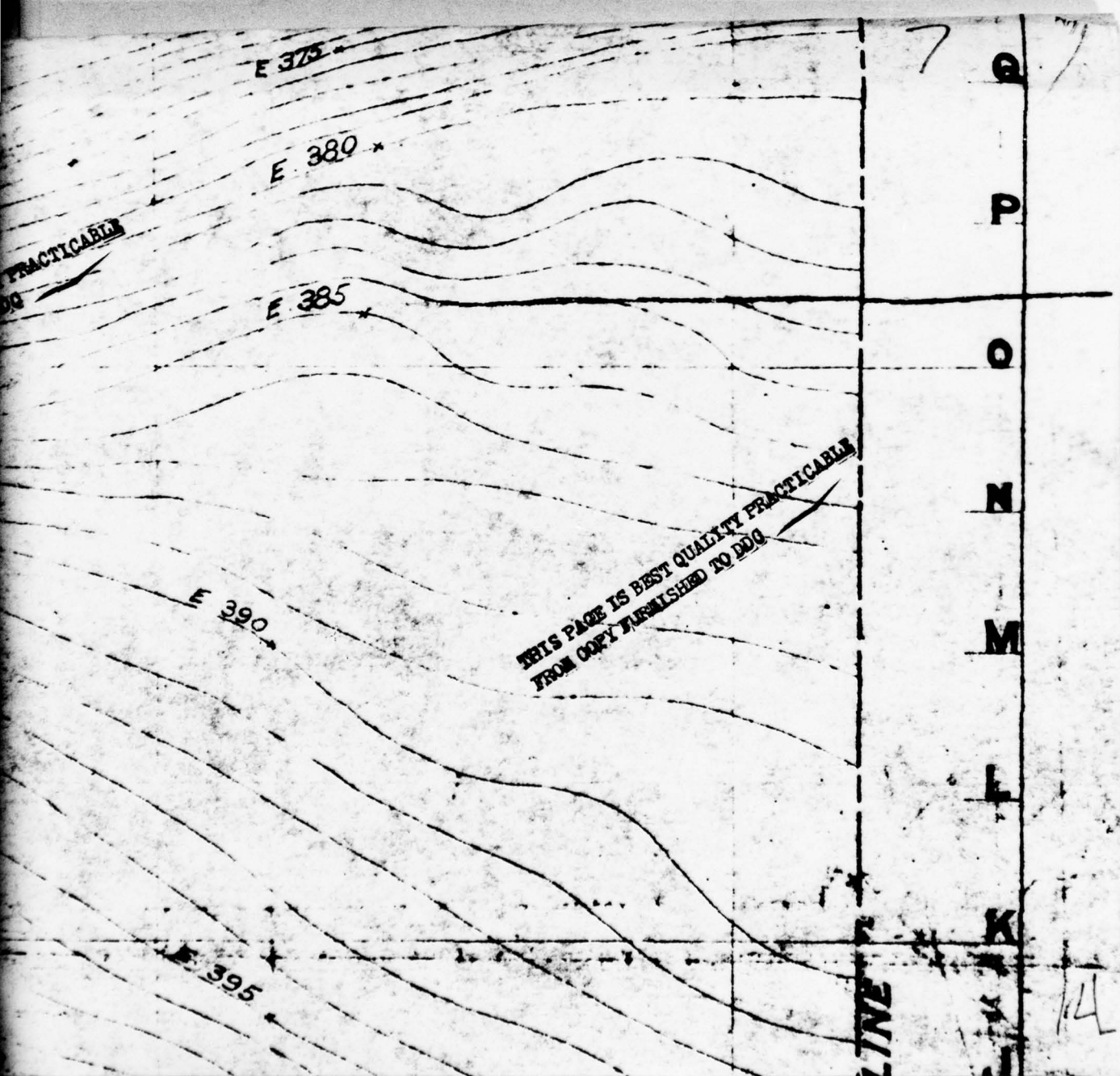
13.9 TO R

23.5 TO R.?

THIS PAGE IS BEST QUALITY PRAC
FROM COPY FURNISHED TO DDG

28.0 NO R

27.8 TO R



THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DQG

7
Q
P
O
N
M
L
K
14

PRESENT E 347
E 347

E 350

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

FLOW LINE - ELEV 415

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

OUTER

INNER

INNER

RC

115

E.360

E.370

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDO

ROCK OUT CROP

*2 to R

E.415

*7 to ROCK

E.420

*4 to R

E.410

★ 83 to R

E 370

E 380

★ 11 to R

E 390

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

THIS PAGE IS
FROM COPY

★ 73 to R

★ 15 to R

E 400

E 406

★ 86 to R

38 IN HARD PAN
NO ROCK

★ 29 to R

10' NO R

E 406

SLOPE

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

THIS PAGE IS BEST
FROM COPY FURNISHED TO DDC

• 17 NHD
SLOPE 2' TO 1'

I

H

G

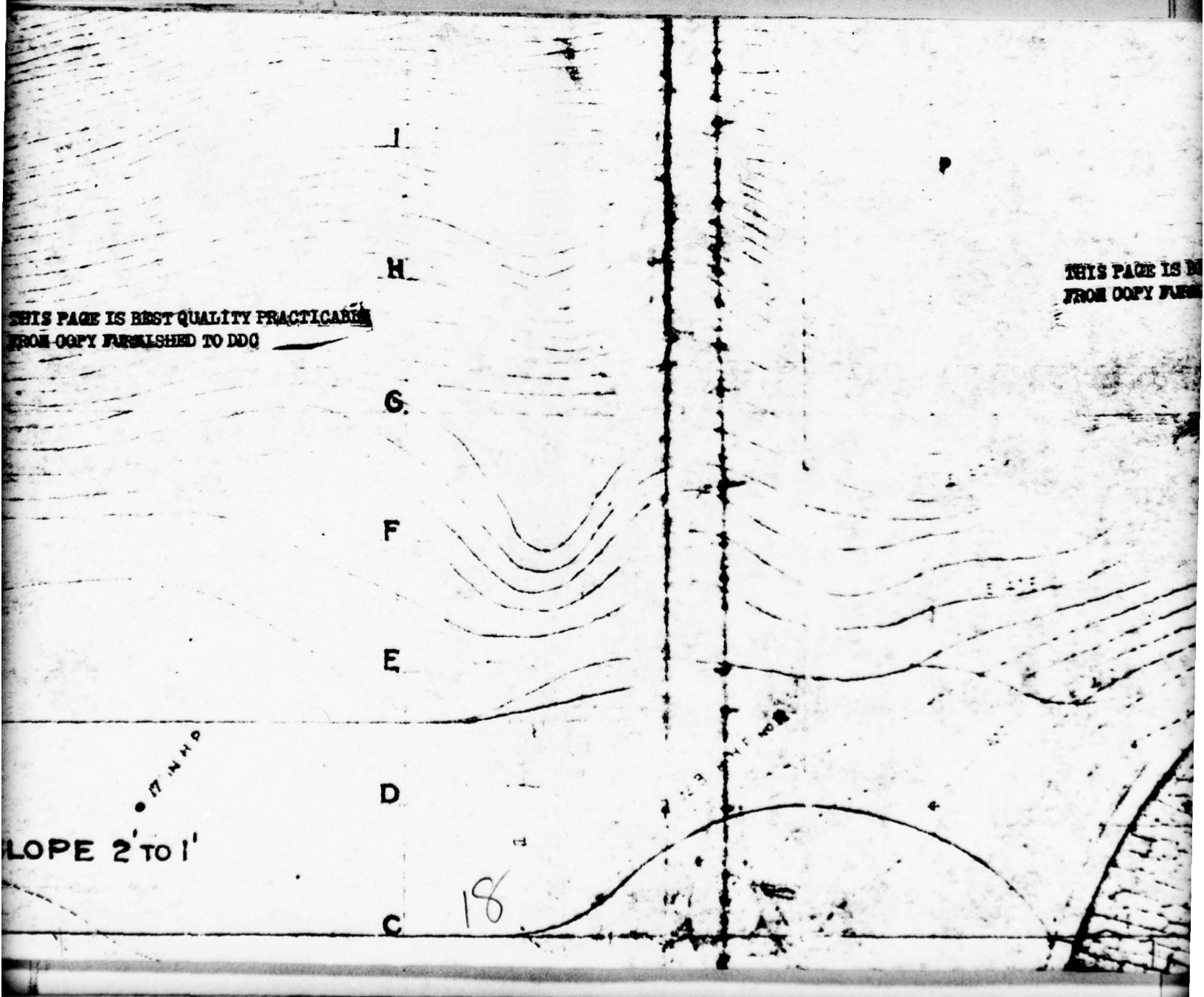
F

E

D

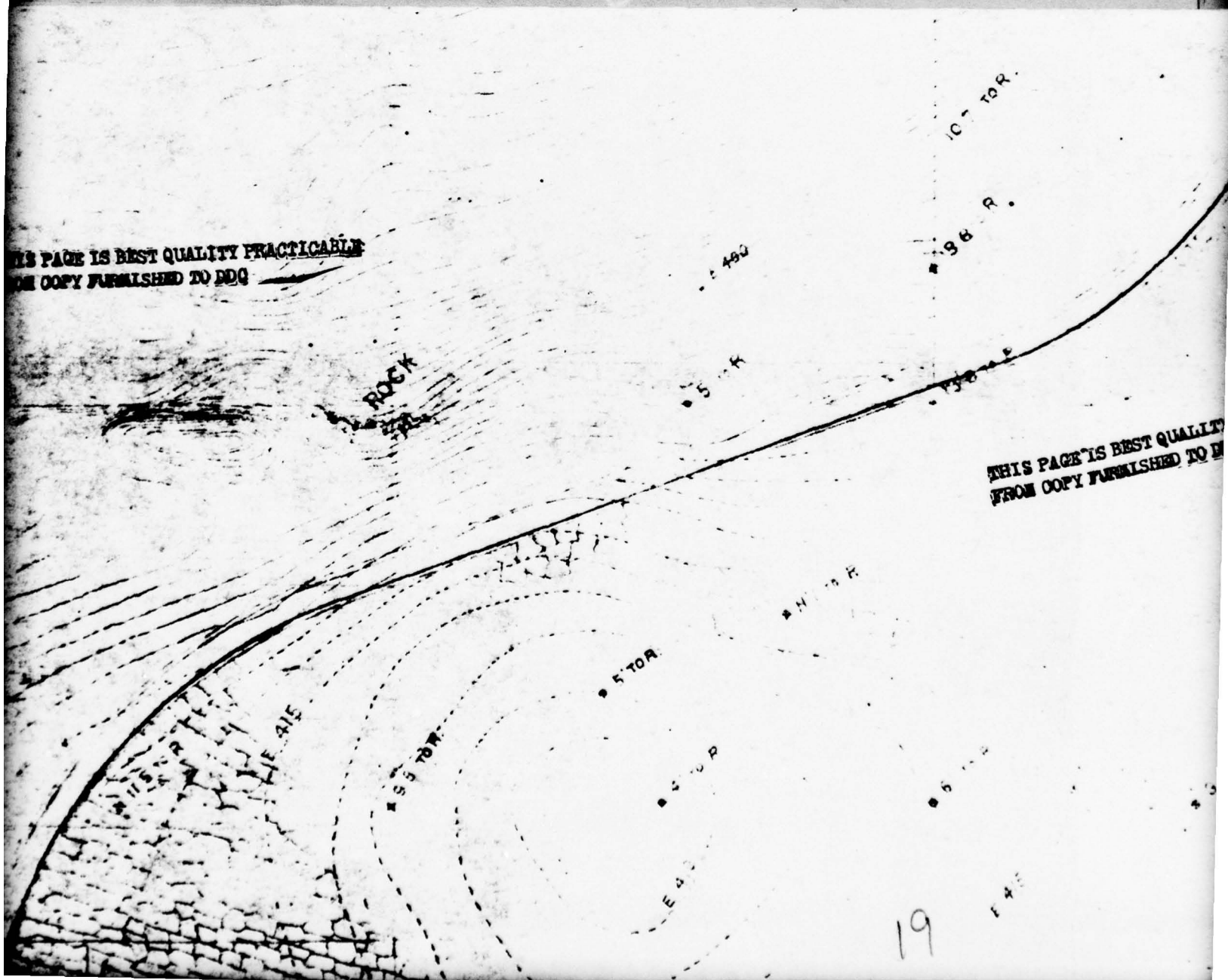
C

18



THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

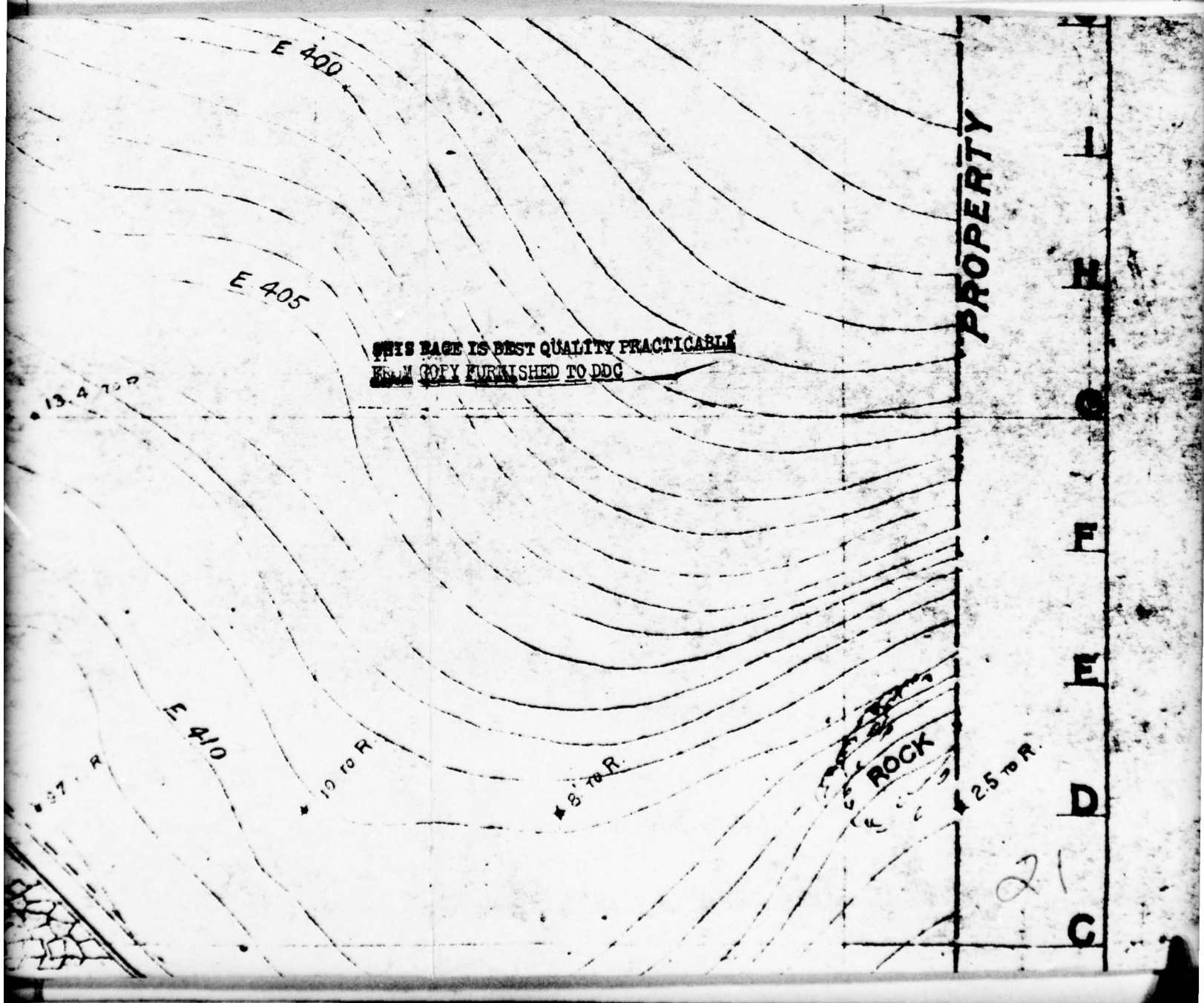
THIS PAGE IS BEST QUALITY
FROM COPY FURNISHED TO DDG



NOT QUALITY PRACTICABLE
FURNISHED TO DDG

FOR SPILLWAY

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG



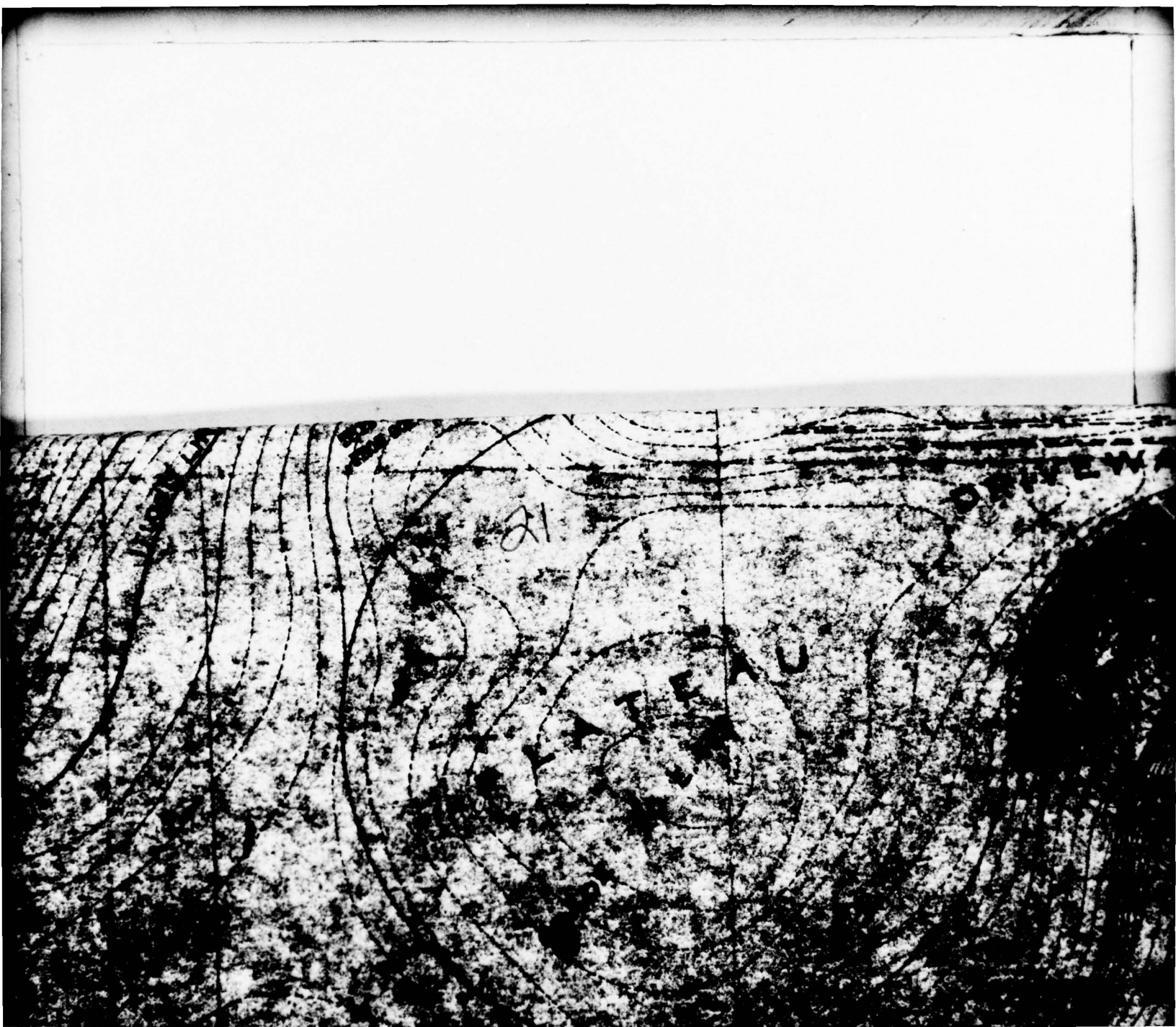
THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

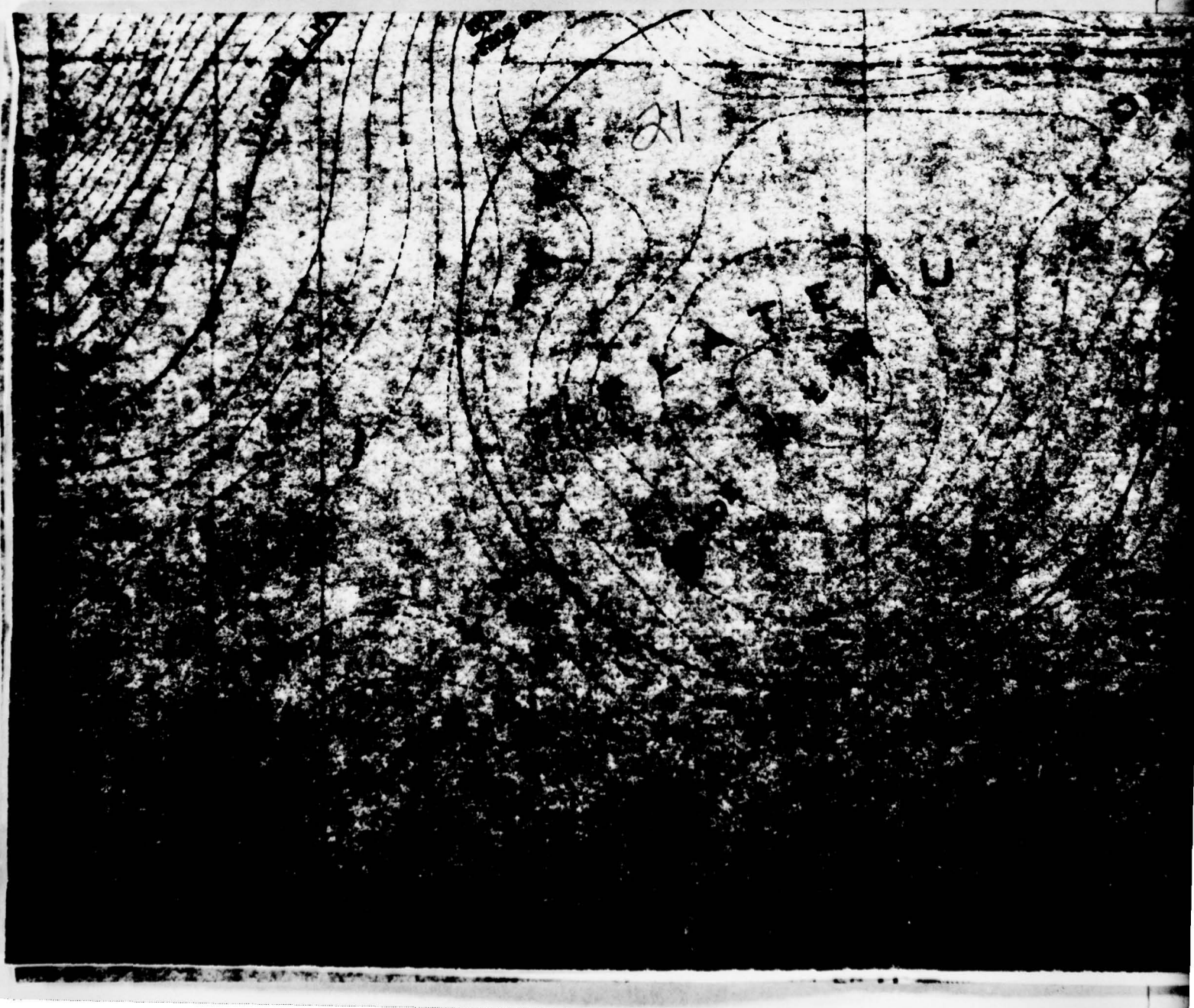
PROPERTY

L
E
O
F
E
D
C

ROCK

21





FILE 415

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDC

22

EARTH DAM WITH RUBBLE CORE

1:0.5

SLOPE 2:1

E. 400

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DGC

E. 300

23

CORE

A

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

THIS PAGE IS BEST
FROM COPY FURNISHED

B

24

C

D

E 414

7. TOR

TOP OF

410.3 TOR

51 TOR

OVERPA

E 410

IS BEST QUALITY PRACTICABLE
FURNISHED TO GO

THIS PAGE
FROM COPY

E 405

4N

5N

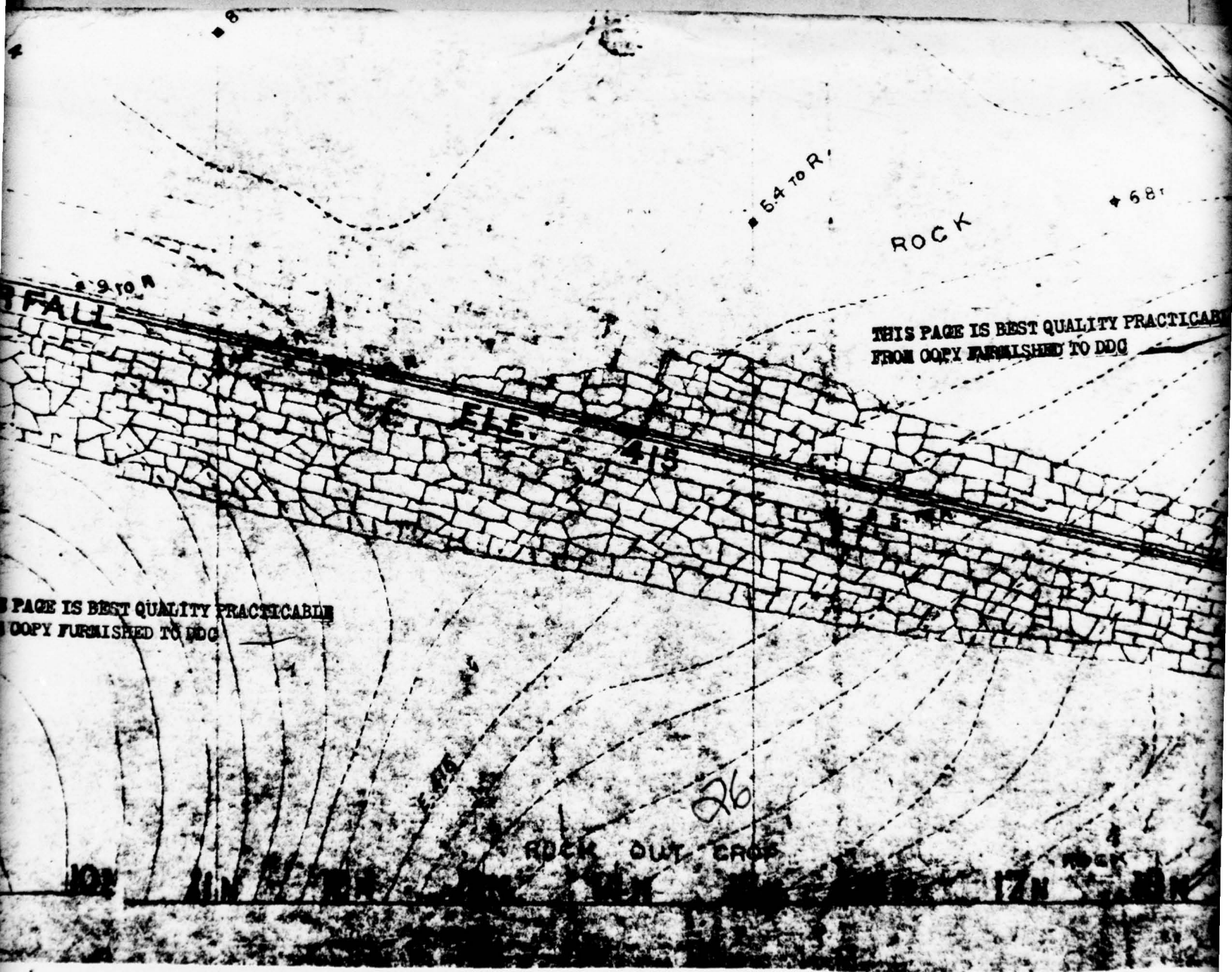
6N

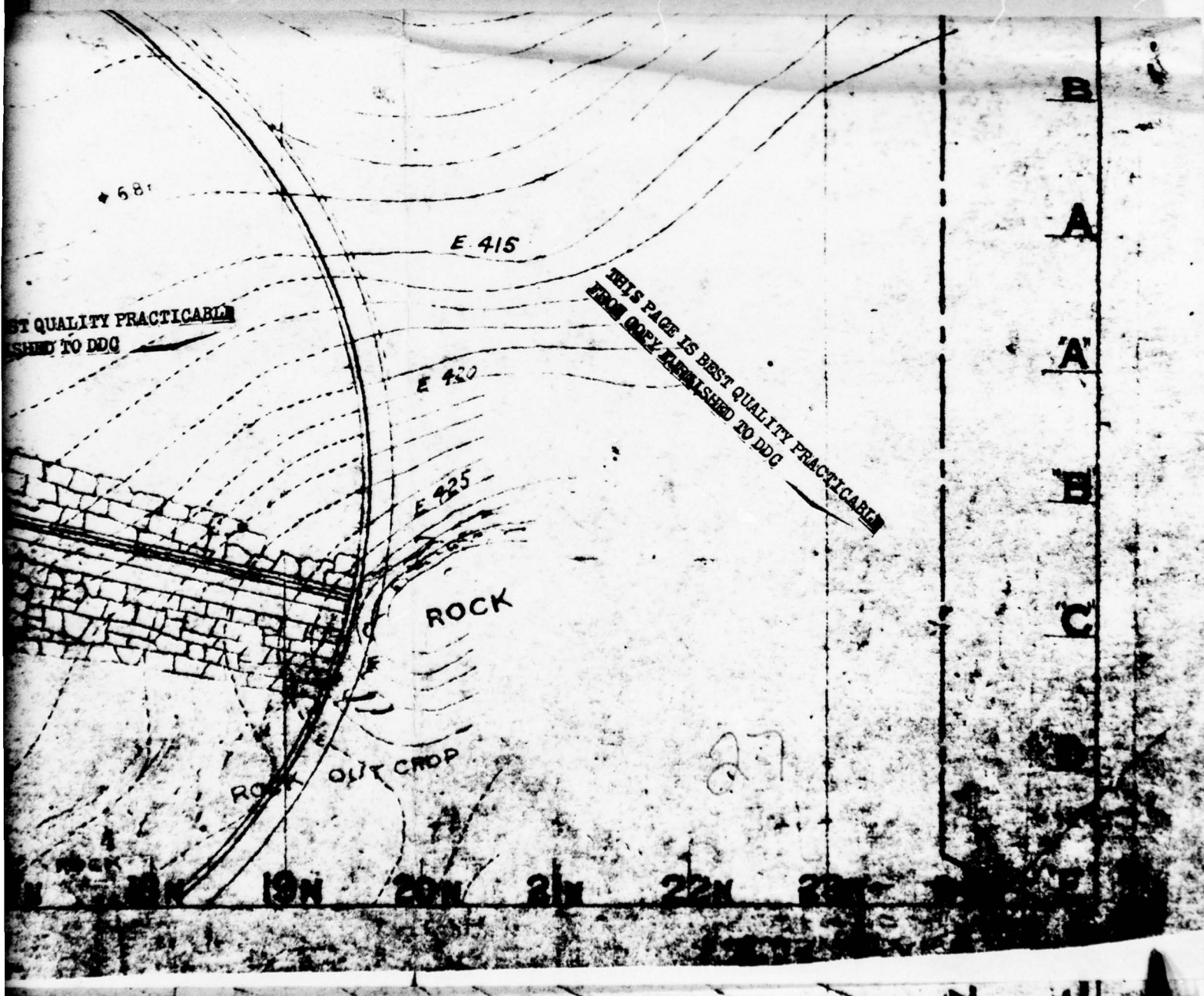
7N

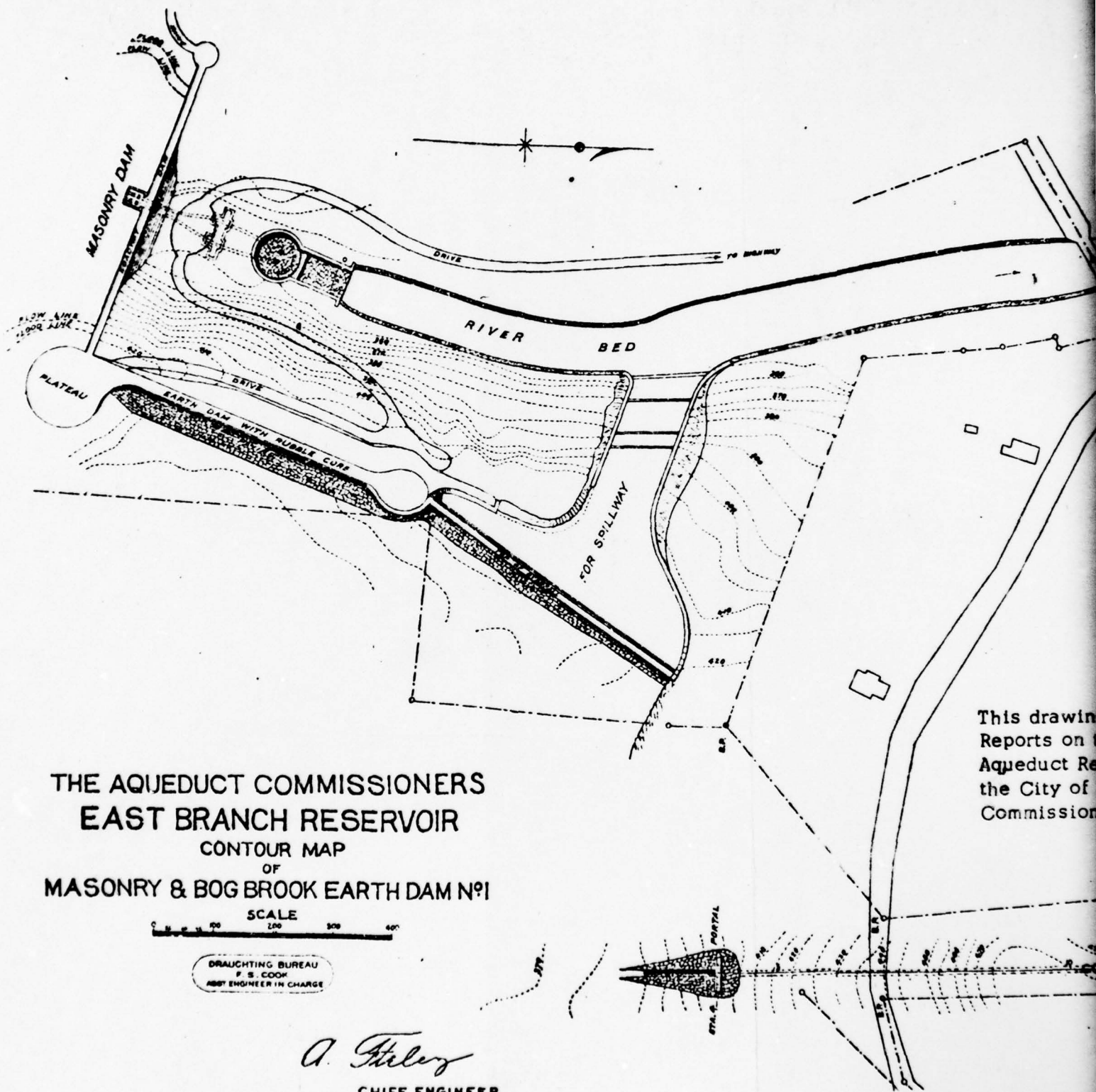
8N

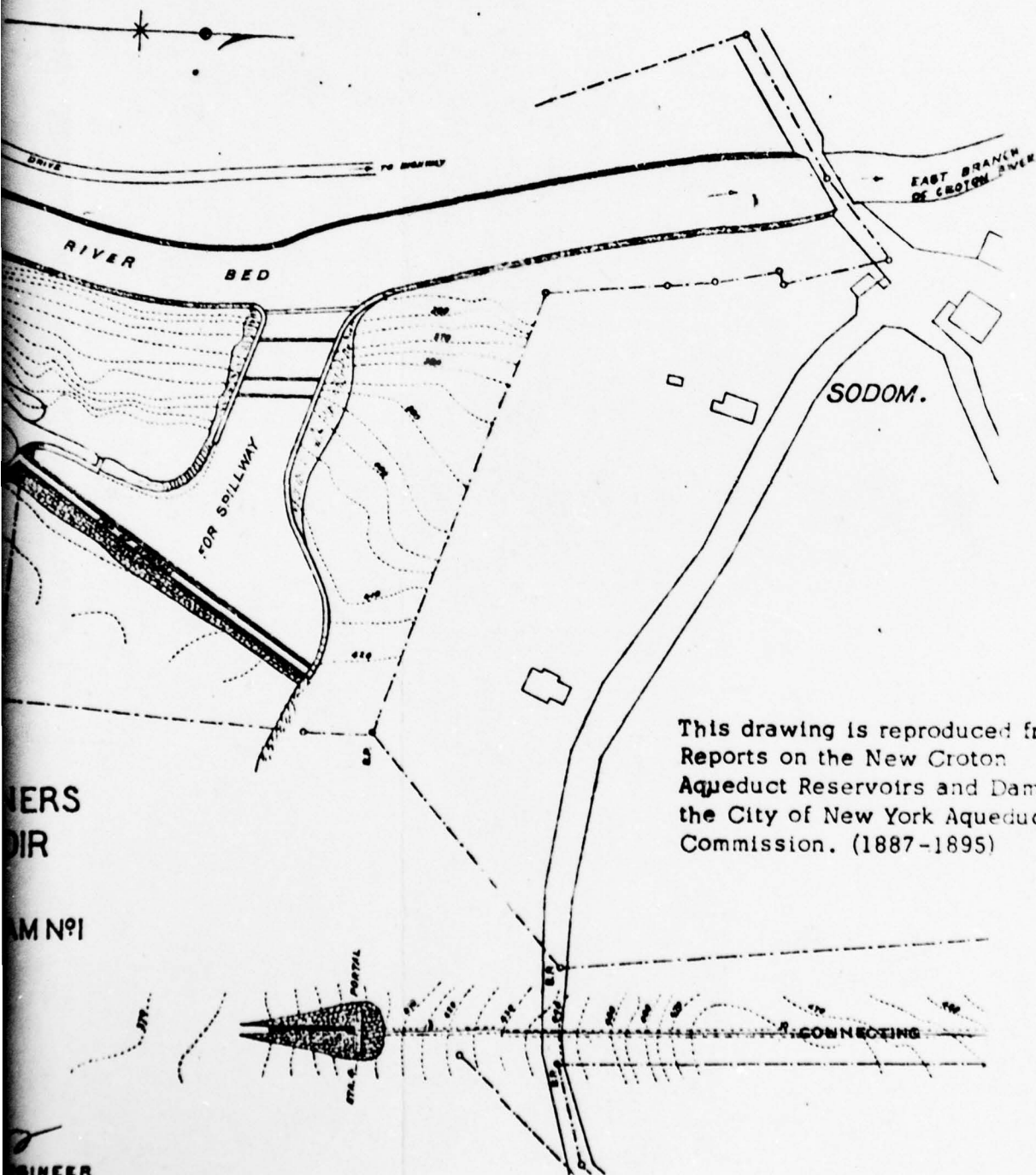
9N

25









This drawing is reproduced from
 Reports on the New Croton
 Aqueduct Reservoirs and Dams to
 the City of New York Aqueduct
 Commission. (1887-1895)

THE AQUEDUCT COMMISSIONERS
EAST BRANCH RESERVOIR

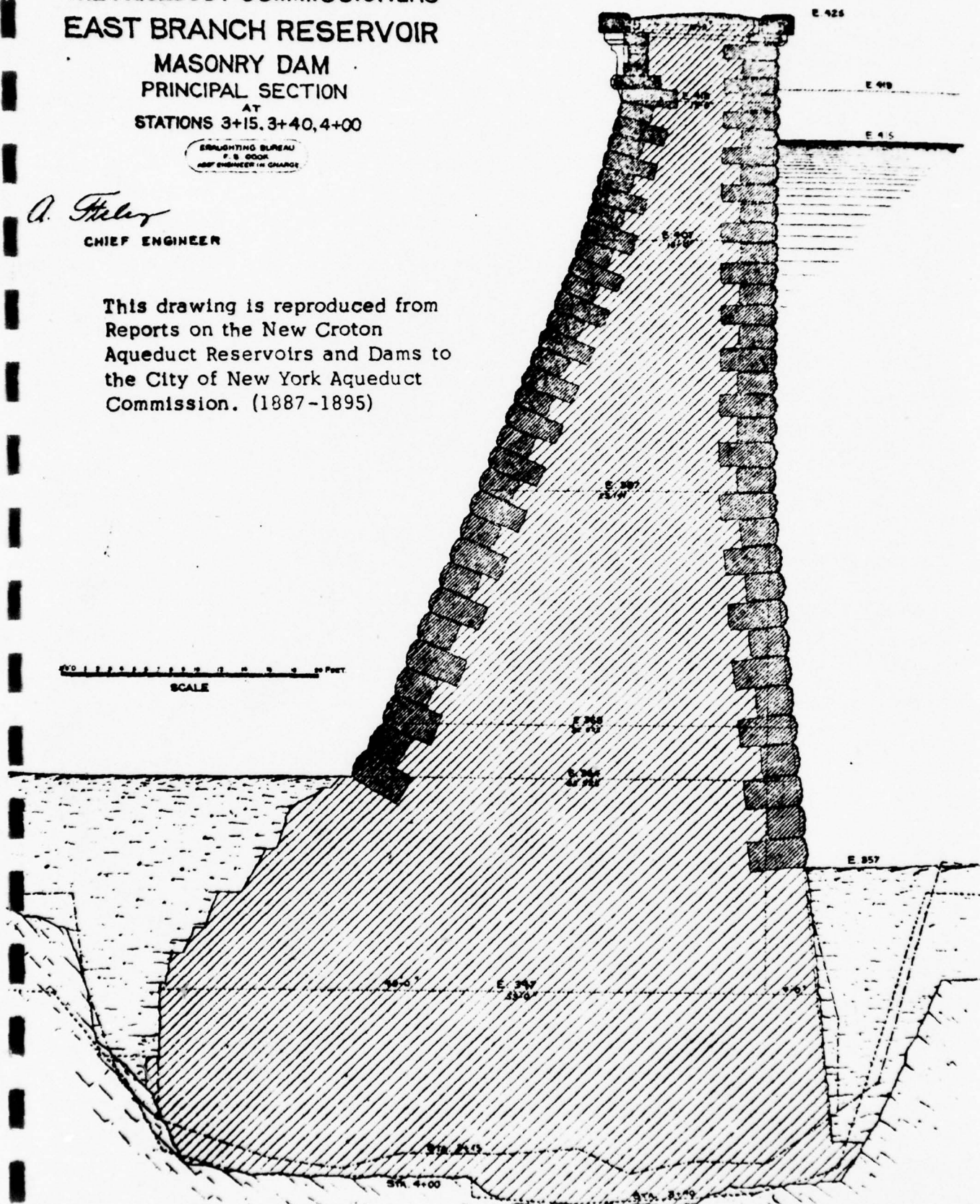
MASONRY DAM
PRINCIPAL SECTION
AT
STATIONS 3+15.3+40, 4+00

ENLIGHTENING BUREAU
P. S. DOOR
ASSISTANT ENGINEER IN CHARGE

A. Fisher

CHIEF ENGINEER

This drawing is reproduced from
Reports on the New Croton
Aqueduct Reservoirs and Dams to
the City of New York Aqueduct
Commission. (1887-1895)

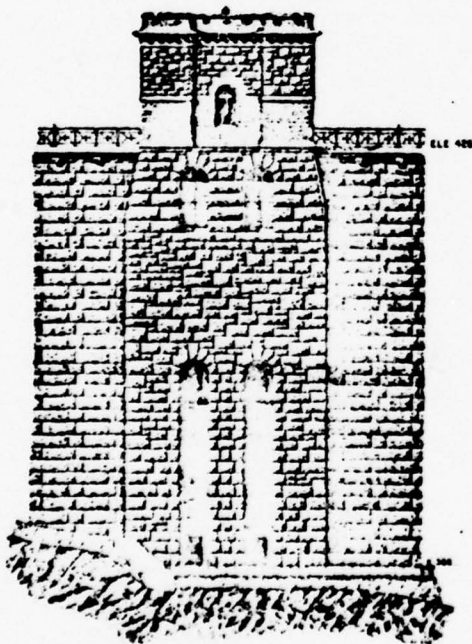


THE AQUEDUCT COMMISSIONERS
PLAN, SECTION AND ELEVATION
OF
EAST BRANCH RESERVOIR
DAM
AND
GATE HOUSE

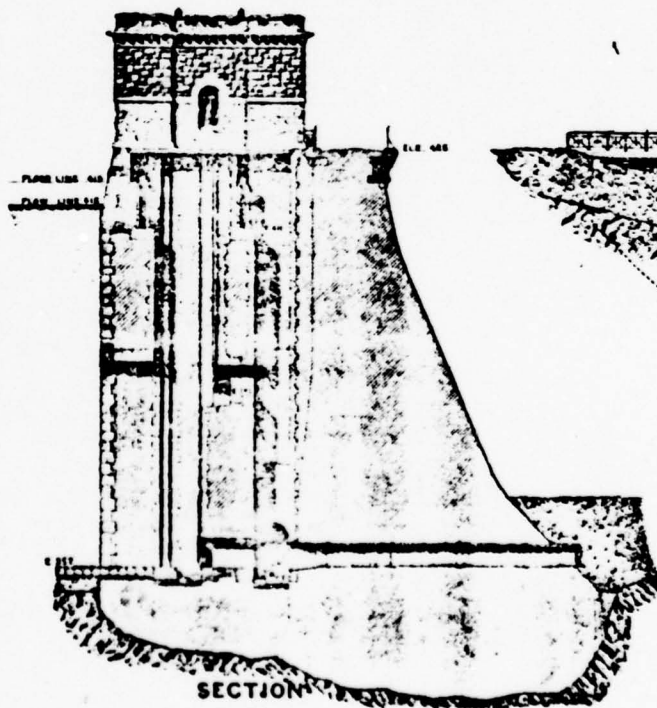
SCALE

ENGINEERING BUREAU
U. S. COAST
AND GEODETIC SURVEY

A. Tuley
CHIEF ENGINEER



ELEVATION



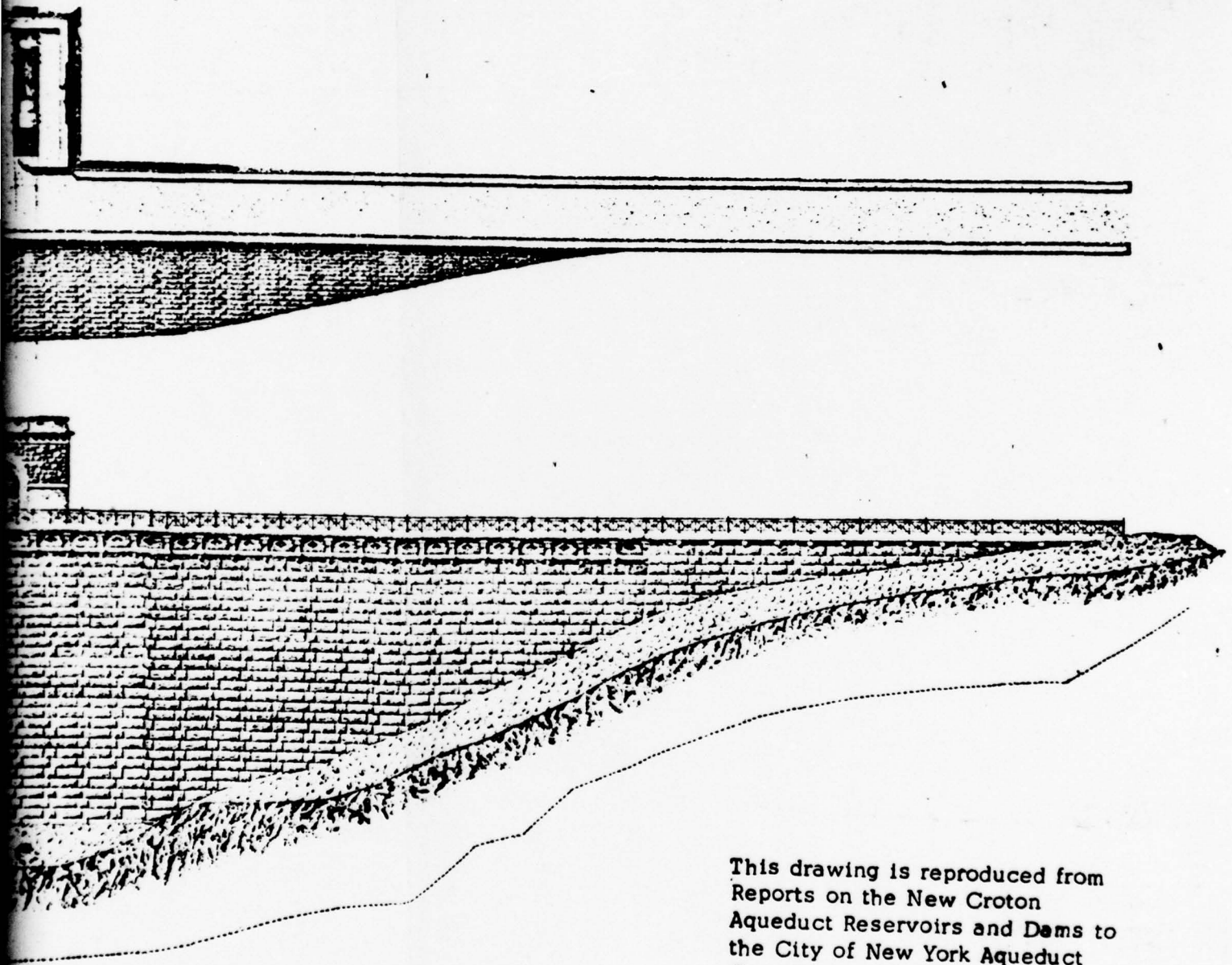
SECTION

PLAN



ELEVATION

2

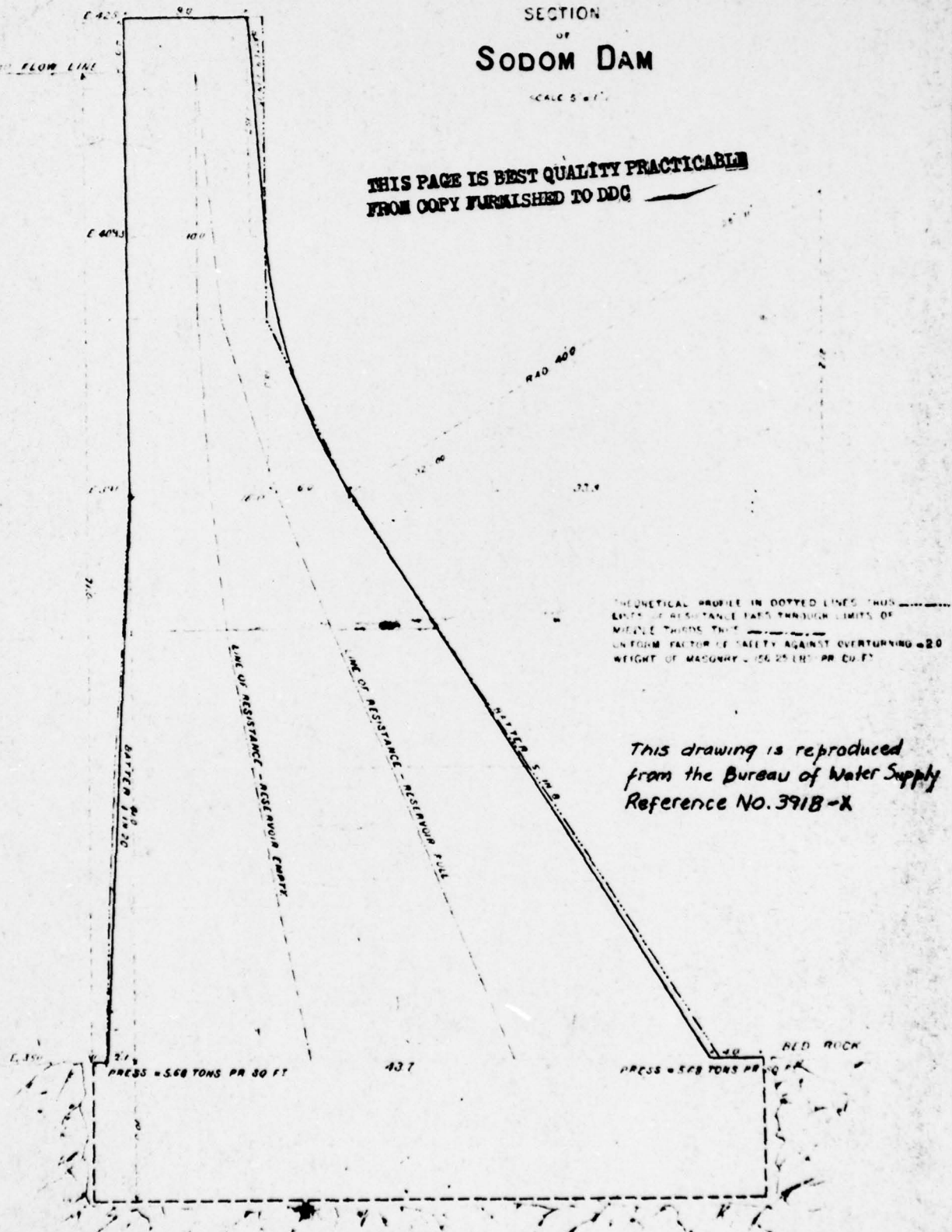


This drawing is reproduced from
Reports on the New Croton
Aqueduct Reservoirs and Dams to
the City of New York Aqueduct
Commission. (1887-1895)

SECTION OF SODOM DAM

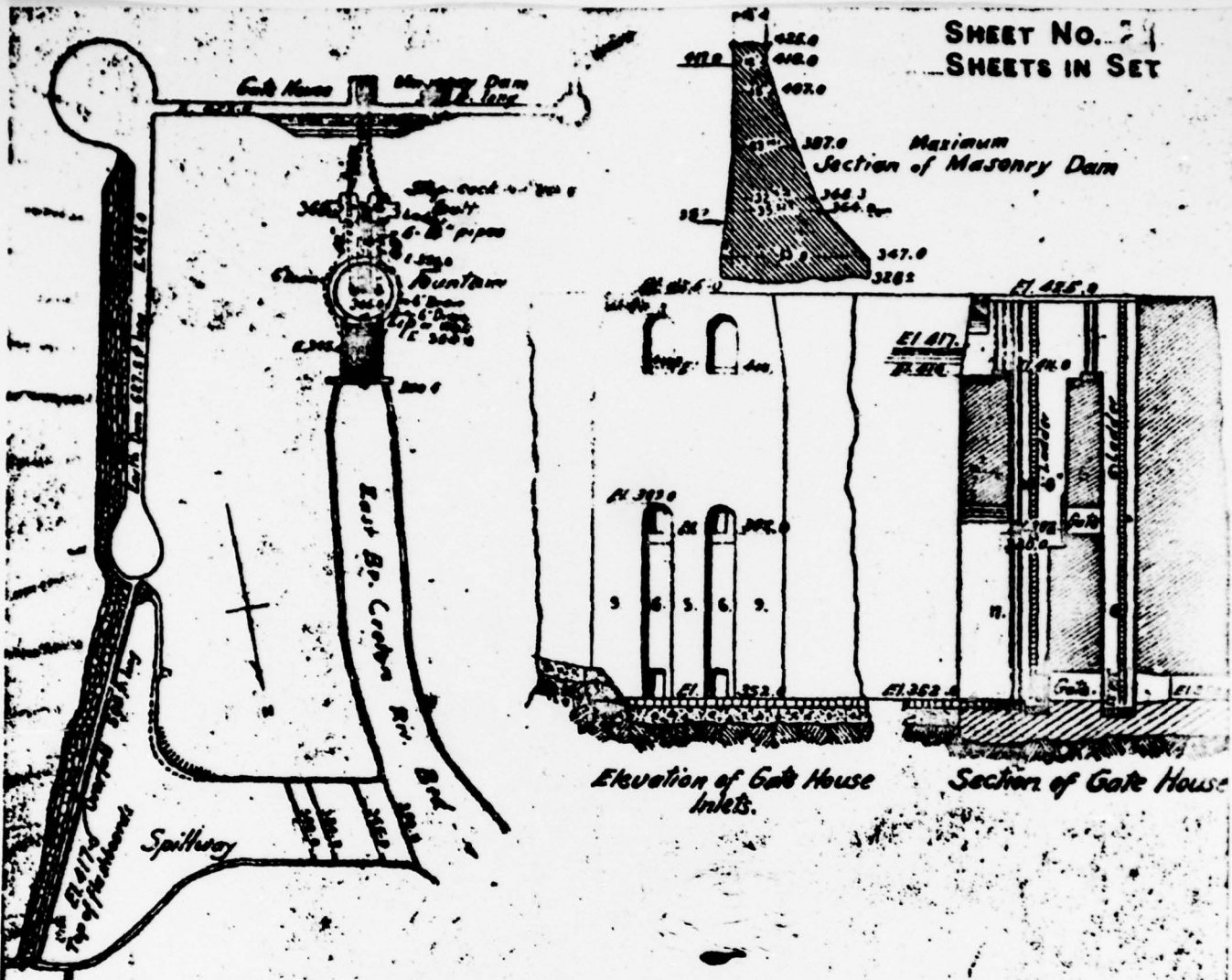
SCALE 5" = 1'

THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG



This drawing is reproduced
from the Bureau of Water Supply
Reference No. 391B-X

SHEET NO. 7
SHEETS IN SET



Inlets		Outlets		Gates		Stop-cocks		Remarks.
Number	Shape and Dimension	Number	Shape and Dimension	Number	Size	Number	Diam.	
2		2		2	2.5' x 6'	2	48"	351.5
	Elevation of Invert 410.		Elevation of Invert 361		Elevation of Invert 382.			
2				2	2.5' x 5'	2	36"	352.
	Elevation of Invert 352.				Elevation of Invert 352.			
				5	12"			353.

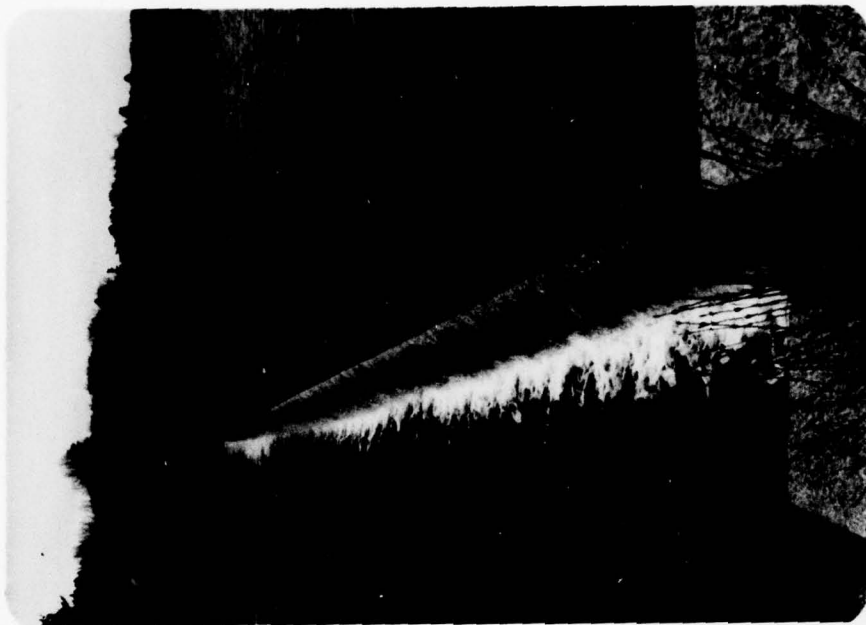
THIS PAGE IS BEST QUALITY PRACTICABLE
FROM COPY FURNISHED TO DDG

CITY OF NEW YORK
THE AQUEDUCT COMMISSIONERS
DOUBLE RESERVOIR "I"
EAST BRANCH RESERVOIR
SODOM DAM
ACCESSION NO.

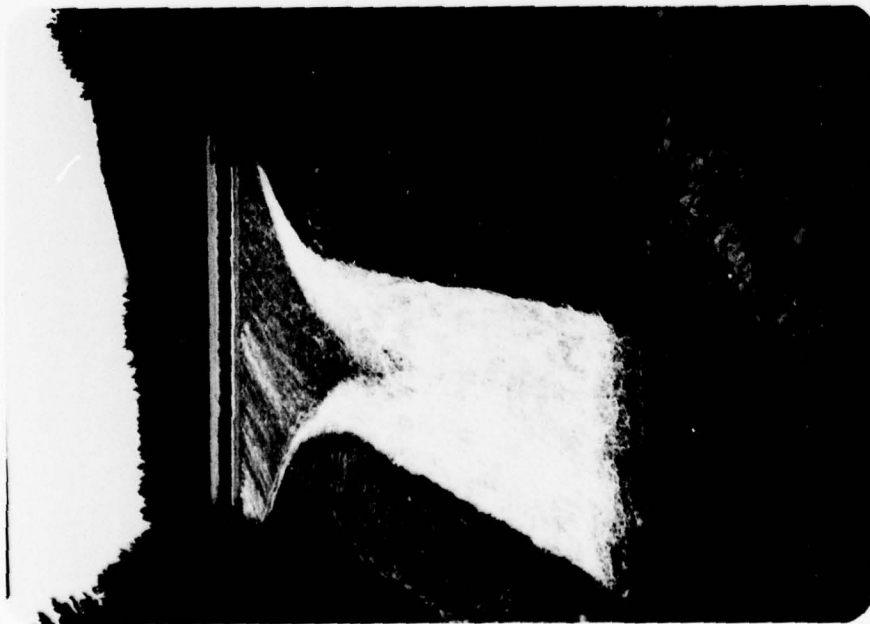
Drawn by A.S.F.
Traced by W.E.K.
Checked by W.E.K. & J.P.G.

PHOTOGRAPHS

APPENDIX A



SPILLWAY SILL (LOOKING NORTH)



OVERVIEW OF SPILLWAY



MASONRY SPILLWAY TRAINING WALL, WITH RUNNING WEEP
HOLE AND OPENINGS IN ROCK BELOW FIRST COURSE OF STONE



EMBANKMENT SECTION, CREST AND DOWNSTREAM SLOPE



EMBANKMENT SECTION , UPSTREAM SLOPE

ENGINEERING DATA CHECKLIST

APPENDIX B

CHECKLIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM SODOM

ID # 31

ITEM

REMARKS

AS-BUILT DRAWINGS *None available. Available dwgs include "Aqueduct Commission Plan" dated Oct 14, 1887. Most accurate drawings found in "Aqueduct Comm" Reports on New Croton Aqueduct, 1887-1895*

REGIONAL VICINITY MAP

USGS

CONSTRUCTION HISTORY *Described in Aqueduct Comm Reports on New Croton Aqueduct 1895-1907; also in Wegmann "Design and Construction of Dams", Sixth Ed 1918*

TYPICAL SECTIONS OF DAM *As above, including Reports and Wegmann's text. Also BOWS, dwg 3918-X undated (circa 1887)*

OUTLETS-PLAN *Schematic in 1887-1895 Reports*

-DETAILS *None available*

-CONSTRAINTS *None available*

-DISCHARGE RATINGS *From weir measurements at outlet channel (200 MGD with both 48" pipes wide open, Approx.)*

RAINFALL/RESERVOIR RECORDS

Available from Carmel Section Office, BOWS also at Katonah Office.

ITEM	REMARKS
------	---------

DESIGN REPORTS	<i>None available</i>
----------------	-----------------------

GEOLOGY REPORTS *None available*

DESIGN COMPUTATIONS *None*

HYDROLOGY & HYDRAULICS *None available*

DAM STABILITY *None except for some notes on Dwg 3918X*

SEEPAGE STUDIES *None available*

MATERIALS INVESTIGATIONS

BORING RECORDS *None except for notes on soundings*

LABORATORY *N.A. on 1887 Aqueduct & main Plan.*

FIELD *None available*

POST-CONSTRUCTION SURVEYS OF DAM *None available*

BORROW SOURCES *None available*

ITEMREMARKS

MONITORING SYSTEMS None in use except weir
at fountain.

MODIFICATIONS Permanent "Flashboards" (stone)
added to raise spillway sill from El 415
to El 417 (Croton datum)

HIGH POOL RECORDS Available at BOWS Carmel
office

POST CONSTRUCTION ENGINEERING None

STUDIES AND REPORTS None

PRIOR ACCIDENTS OR FAILURE OF DAM None reported

DESCRIPTION

REPORTS

MAINTENANCE No formal program or schedule

OPERATION Little operation, if any

RECORDS Record kept of closing and opening
of gates

Note: No O & M Manual

ITEMREMARKS

SPILLWAY PLAN *On dwgs in Aqueduct Comm.
Reports; schematic*

SECTIONS *Schematic on plans by Aqueduct
commission were modified by
omission of steps in tailrace channel*

DETAILS

None

OPERATING EQUIPMENT *Schematics only in 1887-1895 Reports*

PLANS & DETAILS

VISUAL INSPECTION CHECKLIST

APPENDIX C

VISUAL INSPECTION CHECKLIST

1. Basic Data

a. General

Name of Dam SODOM Hazard Category HIGH
County PUTNAM ID# 31
Stream Name East Branch Tributary of CROTON
Location PUTNAM County Nearest Town (P.O.) SODOM
Longitude 73°35'30" E Latitude N41°23'30" Other Directions _____
0.3 mi S of Sodom; 1.5 mi upstream of Brewster
Date of Insp 27 Apr 1978 Weather Cloudy Temperature 50-55°

b. Inspection Personnel John Burdick, Mech Eng;
Glen Gaydar, Mech. Eng; Paul Stuhl,
Structural Eng; Anthony Dolcinascio,
Geotechnical Eng. All with TAMS

c. Persons Contacted MR John Birrell, Carmel
Section Eng; Mr Ed Stoorza, Forman,
Carmel Section. BOWS personnel

d. History: Date Constructed Feb 22, 1888 - Oct 31, 1892
Present Owner Bureau of Water Supply, NYC
Designed by Aqueduct Comm. N.Y.C
Constructed by Sullivan Rider & Dougherty
Recent History _____

2. Technical Data Masonry

Type of Dam with Earth Emb. Drainage Area 80.28 sq mi - Acres
Height 98' above found. Length Masonry Dam 500'
Earth Dam 600'
Upstream Slope 1(V):2(H) Downstream Slope 1(V):2(H)
Crest Width 12' Masonry dam Freeboard at Spillway Crest 10 ft
20' Earth dam

Low Level Control: (Type and Size)

Multi level sluice gates & overflow weir w inlet and outlet chambers at gate house: 2-48 inch outlet pipes to unit. 2-48 discharge pipes and 5-12" Fountain pipes

Valve Condition Operable - good cond.

Emergency Spillway Type (Material)

Masonry

Width 4 to 5' ft at sill

Only one service spillway;

No Emergency Spillway

Side Slopes Masonry; 3(H) on 1(V) approach

Height (Crest to Top) 10 ft

Exit Slope Graded 50'(V) in 400'(H)

Exit Length ~ 400'

Ponded Surface Area _____ Acres

Capacity (Normal Level) 16000* Acre Feet

Capacity Emergency Spillway Level _____ Acre Feet

3. Embankment

600' long, 20' wide at crest, earth

a. Crest 20 ft wide (EI 425 Mean tide at Sing Sing)

(1) Vertical Alignment Uniform, Crest EI 425

(2) Horizontal Alignment Straight N-S direction

(3) Longitudinal Surface Cracks None visible

(4) Transverse Surface Cracks Non visible

(5) General Condition of Surface Grassed surface, in good condition

(6) Miscellaneous _____

* Bog Brook 13500 AF not included

b. Upstream Slope 1 (V):2.0 (H) Uniform

(1) Undesirable Growth or Debris Minor amounts of high grass and brush near top of rip rap

(2) Sloughing, Subsidence, or Depressions None visible

(3) Slope Protection Handplaced Riprap stone below EL 421 ±, stones average 1' size hand placed (Sizes 1' x 0.8 x 1.0 to 0.0)

(a) Condition of Riprap Good to excellent

(b) Durability of Individual Stones Good

(c) Adequacy of Slope Protection Against Waves and Runoff Apparently good - no damage visible

(d) Gradation of Slope Protection - Localized Areas of Fine Material As above

(4) Surface Cracks None visible

c. Downstream Slope 1 (V): 2 (H) grassed

(1) Undesirable Growth or Debris Some high grass otherwise well maintained

- (2) Sloughing, Subsidence, or Depressions; Abnormal Bulges or Non-Uniformity

None visible

- (3) Surface Cracks on Face of Slope None visible

- (4) Surface Cracks or Evidence of Heaving at Embankment Toe

None visible

- (5) Wet or Saturated Areas or Other Evidence of Seepage on Face of Slope; Evidence of "Piping" or "Boils"

None visible

- (6) Fill Contact with Outlet Structure

Good - no seepage

- (7) Condition of Grass Slope Protection Generally well maintained - Some rutting caused by tractor mower.

d. Abutments

- (1) Erosion of Contact of Embankment with Abutment from Surface Water Runoff, Upstream or Downstream

None visible

- (2) Springs or Indications of Seepage Along Contact of Embankment with the Abutments

None visible

- (3) Springs or Indications of Seepage in Areas a Short Distance
Downstream of Embankment - Abutment Tie-in

None visible

- e. Area Downstream of Embankment, Including Tailrace Channel

- (1) Localized Subsidence, Depressions, Sinkholes, Etc. _____

None visible

- (2) Evidence of "Piping" or "Boils" _____

None visible

- (3) Unusual Presence of Lush Growth, such as Swamp Grass, etc. _____

No

- (4) Unusual Muddy Water in Downstream Channel _____

No

- (5) Sloughing or Erosion _____

None visible

- (6) Surface Cracks or Evidence of Heaving Beyond Embankment, Toe _____

None visible

(7) Stability of Tailrace Channel Sideslopes _____

No signs of distress

(8) Condition of Tailrace Channel Riprap Very good

(Flat surfaced hand placed riprap - chunked with mortar forms floor)

(9) Adequacy of Slope Protection Against Waves, Currents and Surface Runoff

Apparently good, no signs of distress

(10) Miscellaneous _____

f. Drainage System No drainage systems

(1) Condition of Relief Wells, Drains and Appurtenances _____

Not applicable

(2) Unusual Increase or Decrease in Discharge from Relief Wells

Not applicable

4. Instrumentation

(1) Monumentation/Surveys None

(2) Observation Wells None

(3) Weirs Weir at outlet fountain
measures regulating gate releases

(4) Piezometers None

(Other)

5. Reservoir

Inspected from dam and USGS Topo

a. Slopes Visible slopes in vicinity of
dam are stable

b. Sedimentation

6. Spillways

Only one spillway which is service spillway

a. Principal Spillway: Inlet Condition

Pipe Condition

General Remarks (include information such as recently repaired, potential for debris accumulation, special items of note, etc.)

Service spillway is masonry wall approx 8' high, ungated. Sill and visible parts of spillway in good condition. Water being spilled at time of inspection.

~~b. Emergency Spillway: General Condition~~ Note: Spillway Elevation was originally at EI 415. It was subsequently raised to EI 417

Tree Growth

Erosion

Other Observations

7. Structural (if required) See Attached Appendix

See attached appendix for Structural Comments

8. Downstream Channel

D/S channel is East Branch of Croton

a. Condition (obstructions, debris, etc.)

No obstructions, channel
is riprapped

b. Slopes

Side slopes of channel
are flat (3 or 4 on 1) and stable

c. Approximate No. Homes and Population

Dam is approx. 1/2 mile South of Sodem
and 1.5 mi U/S of Brewster

d. General

A. Dolanuscolo
TEAM CAPTAIN

STRUCTURAL INSPECTION CHECKLIST

PHASE I DAM INSPECTION

1. ~~Concrete Surfaces~~ Masonry surfaces of gravity dam are in good condition and dry
2. Structural Cracking None visible
3. Movement - Horizontal and Vertical Alignment None visible
4. Junctions with Abutments or Embankments Good condition
5. Drains - Foundation, Joint, Face None
6. Water Passages, Conduits, Sluices Water passages thru dam not inspected
7. Seepage or Leakage None visible
8. Monolith Joints - Construction Joints Not applicable
9. Foundation Not visible, Masonry structure founded on rock

10. Abutments

11. Control Gates Visible portion of gate stems
stands hoists etc in generally good
condition

12. Approach and Outlet Channels N.A.

13. Stilling Basin

14. Intake Structure

15. Settlement No differential settlement
visible

16. Stability

a. Overturning Calculations not required for Phase I

b. Sliding // // // // //

c. Seismic Zone I - no analysis required

17. Instrumentation No instrumentation

a. Alignment

b. Uplift

c. Seismic

18. Miscellaneous

HYDROLOGIC DATA AND COMPUTATIONS

APPENDIX D

Job No. 1487 TIPPETTS-ABBETT-McCARTHY-STRATTON
Project Dam Inspection ENGINEERS AND ARCHITECTS NEW YORK
Subject Sodom Dam -
Spillway Rating Curve

Sheet of
Date 5/2/77
By GRW
Ch'k. by

Spillway Rating - Length = 500'

Head C Q

1.0 3.33 1665

1.5 3.34 3058

2.0 3.33 4707

2.5 3.33 6576

3.0 3.33 8651

4.0 3.33 13320

5.0 3.33 18615

6.0 3.33 24470

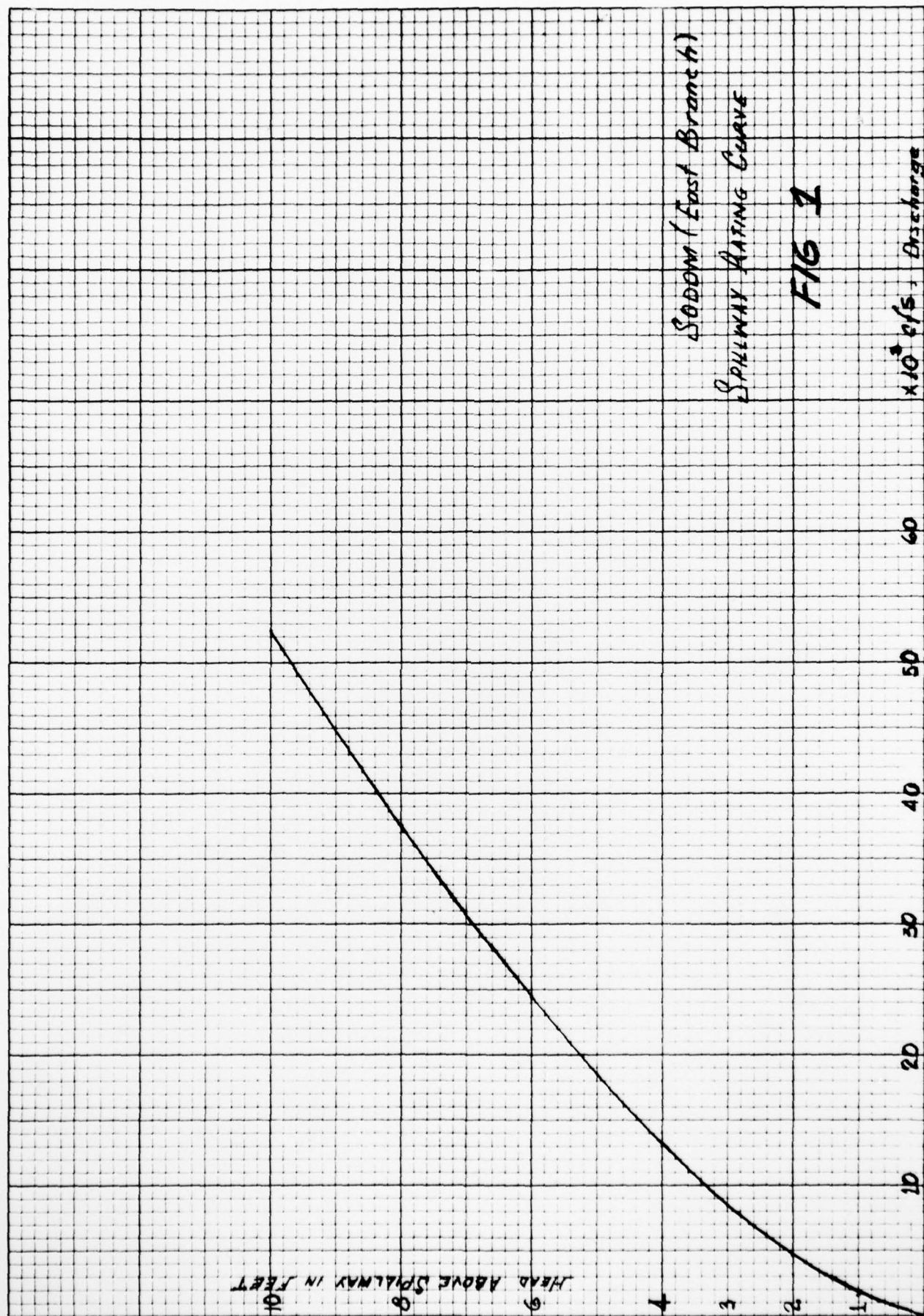
8.0 3.33 37675

} Data from Board
of Water Supply

Top of dam

Floods of Record:

<u>Date</u>	<u>Elev.</u>	<u>Head</u>	<u>Q</u>
Aug. 29, 1955	419.03	2.43	6500
Oct. 16, 1955		2.50	6500



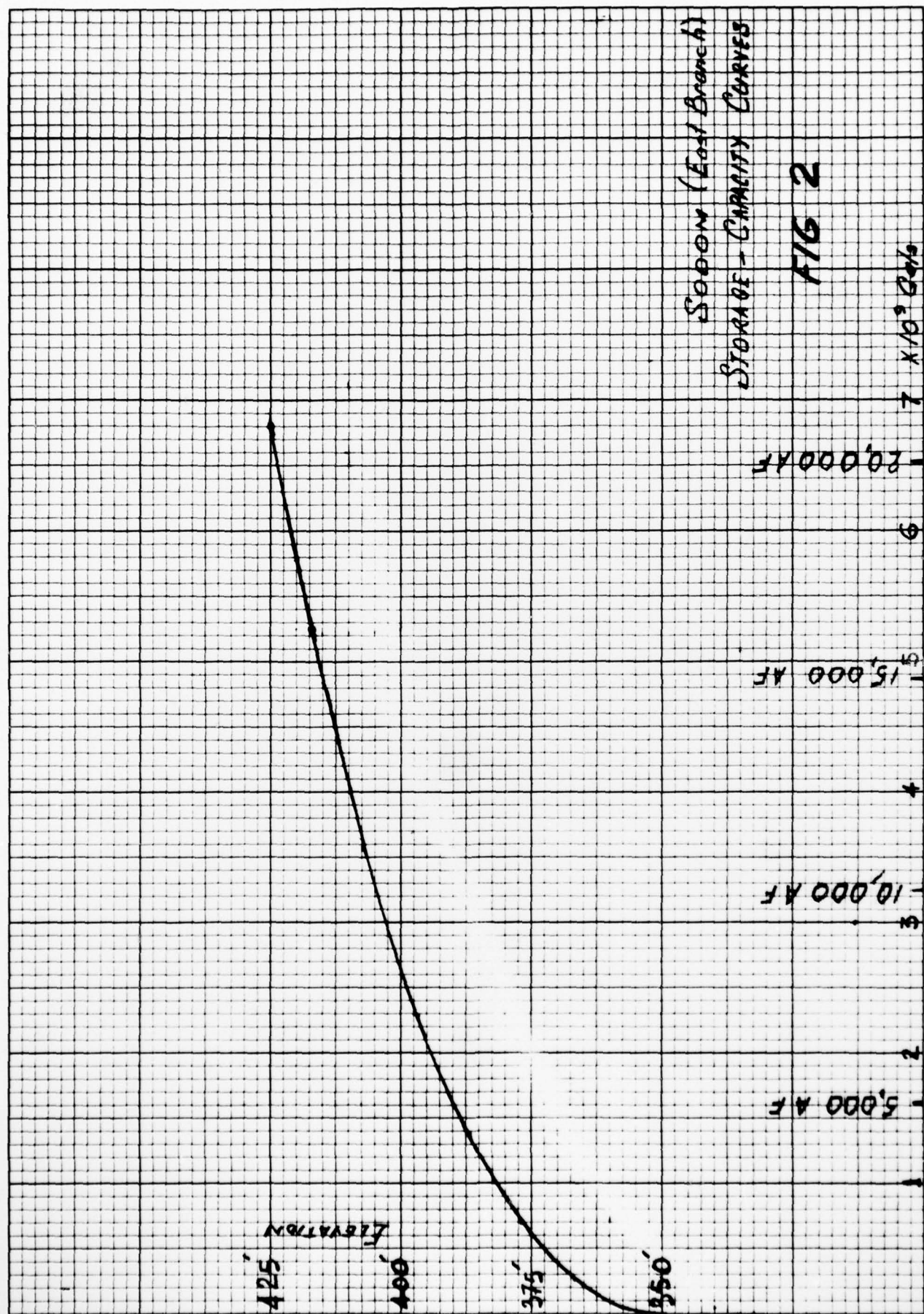


FIGURE 2